POWER

Volume 62 New York, August 25, 1925 *No.* 8

The N. A. S. E. and Power

IN NOVEMBER, 1882, there was started in Chicago a little paper by the name of *Steam*.

Theodore Audel, its founder, editor and manager, is still alive.

In its salutatory *Steam* announced:

> Unlike many periodicals of the day, this paper has a mission of individual good to perform. It is pledged to the advocacy of the foundation of a National Brotherhood of Stationary Engineers. This society is to be formed by representatives of State organizations, which in turn will be composed of local brotherhoods. This society (large as the plan seems) need be no experiment. The marine engineers and the locomotive engineers are thus organized, and the idea is found to be both feasible and advantageous.

In 1884 *Power* was founded. It absorbed *Steam* and with it its advocacy of a national association of practical engineers, which had in the meantime become a fact through the organization in New York in November, 1882, the same month that Mr. Audel's salutatory appeared, of the National Association of Stationary Engineers.

From that day to this *Power* has been a staunch friend of and booster for the N.A.S.E., recognizing and signalizing its services to industry and to power-plant engineering, and aiding as best it could in the realization of its ideals and purposes.

No organization is greater than the ideals of its thinkers, and these ideals must grow and develop with the times. May the coming convention of the N.A.S.E. evolve that far-sighted leadership and impelling enthusiasm that will lead to the realization of the possibilities within its reach.

F. R. Low

New Boiler Plant Saves Tannery $10,000 a Year

AN INVESTMENT of $60,000 pays dividends of 16⅔ per cent. Considering the load and the pressure, return-tubular boilers, stoker-fired, were preferred to water-tube. Labor-saving equipment for coal and ash handling made it possible to operate the plant with one man per shift.

AT WAUWATOSA, on the outskirts of Milwaukee, the new boiler plant of the Forsyth Leather Company is an excellent example of what may be done toward solving the power and steam problems of the small industrial plant. The works in question specializes in the manufacture of high-grade patent leather from the hide to the finished product, with a daily capacity for 1,200 sides, or 600 hides.

With demand for all exhaust steam available for drying leather, heating the large quantities of water required in a tannery and for heating the building, it was evident that the purchase of power would be uneconomical. The problem was to replace equipment that had passed its economical life and through reduction of the allowable pressure had insufficient capacity. The solution was a new boiler plant most complete for its size with stokers and coal- and ash-handling equipment, so that operation was made as nearly automatic as possible. The result was a plant that is being operated by one man, including the unloading of coal and ash removal, and has effected savings in coal and labor aggregating $10,000 a year on a total investment of $60,000. The boiler and furnace efficiency averages 70 per cent as compared to 58 per cent in the old plant. The following is an outline of equipment old and new in order that full details may be available.

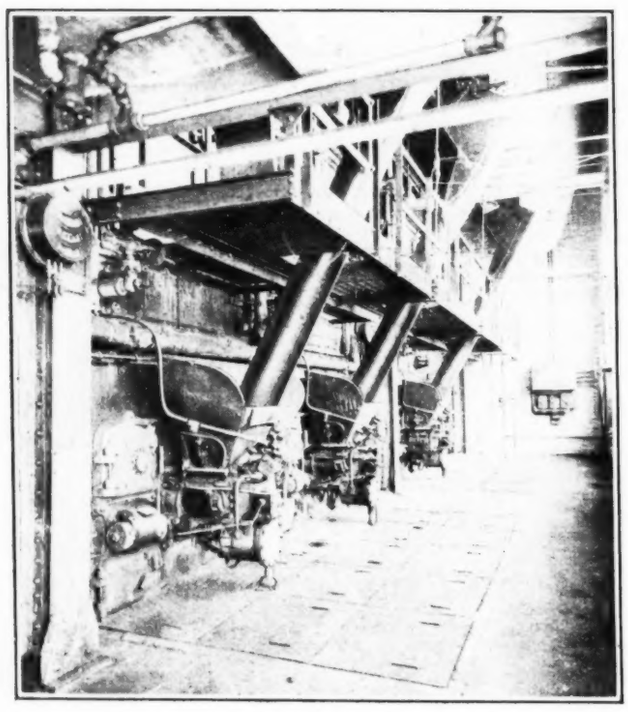

Fig. 1—New three-boiler plant of Forsyth Leather Co.

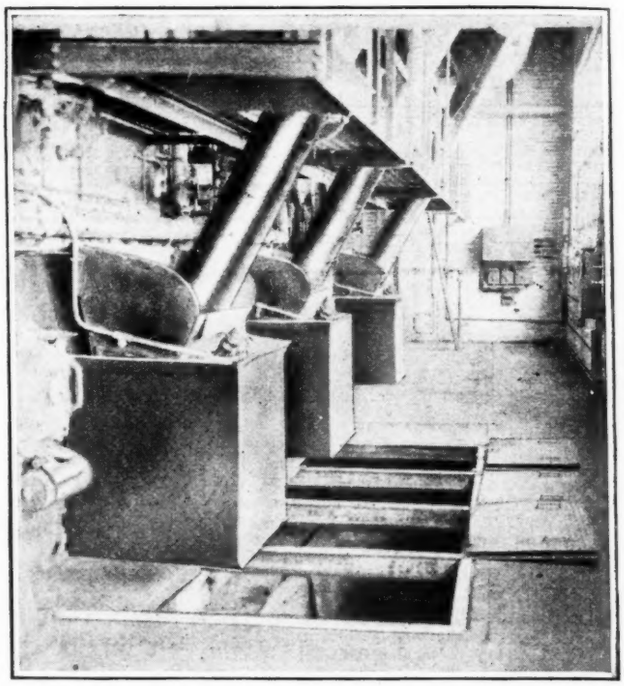

Fig. 2—Method of protecting stokers when removing ash

Engineers Were Called In

Late in 1922 Cahill & Douglas, consulting engineers in Milwaukee, were called in to examine the steam requirements and the plant generally with a view to renew the boiler plant. The boiler equipment consisted of two 72-in. by 18-ft. return-tubular boilers equipped with hand stokers. These boilers were about thirty years old, and the insurance company had reduced the pressure to 90 lb. gage. Coal and ashes were handled manually, the former costing about 30c. a ton to unload by workmen outside of the operating force, which consisted of four men, two on the day shift and one on each of the other eight-hour shifts. Other equipment in the boiler room consisted of two duplex direct-acting steam pumps and a feed-water heater that was still in good condition.

In the engine room the main power unit was an 18x42-in. simple Corliss engine running at 78 r.p.m. with a flywheel 14 ft. in diameter belted to a lineshaft in the tannery. With operating steam pressures ranging from 80 to 85 lb., the engine was overloaded. Owing to the fact that it was in good physical condition, two methods of increasing its power were considered—one to increase the steam pressure and the other to change the rate of speed from 78 to 90 r.p.m. The increase in speed would have given approximately 15

per cent additional capacity and another 15 per cent increase could have been obtained by raising the pressure to 120 lb. gage, making a total of approximately 30 per cent greater power output over existing conditions.

Other equipment in the engine room was a simple horizontal 10x10-in. engine driving a 40-kw. generator for lighting and power, a 30-kw. bipolar generator belted to the main lineshaft and a simple horizontal high-speed engine belted to the hot-blast fan.

As this equipment had been maintained in good operating condition, it was decided that little could be done

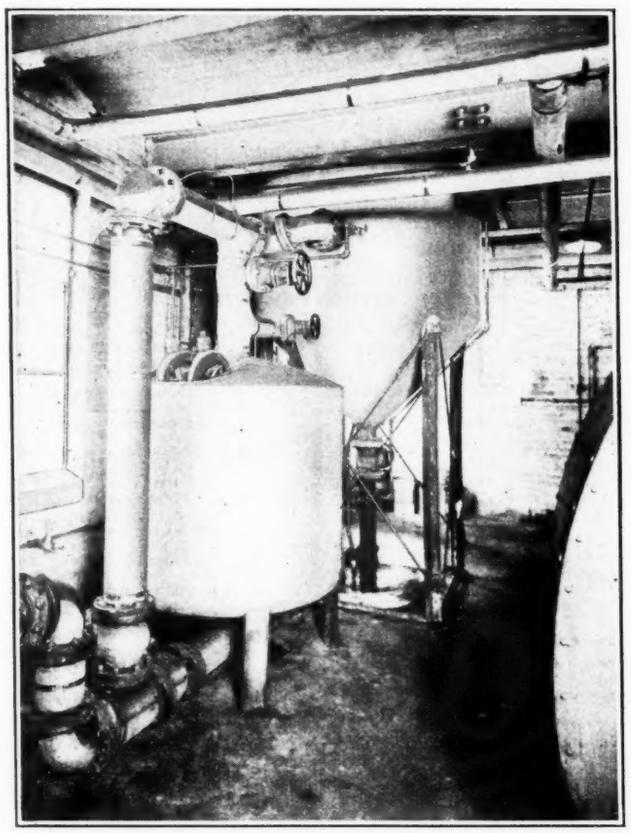

Fig. 3—Hot-process water-softening plant

here that would make a saving of any magnitude in the operating expense, owing to the fact that all the exhaust steam was required for heating and drying, in addition to some high-pressure steam, and all water of condensation was returned to the boilers. With new boilers it would be possible to raise the pressure on the large power engine to 125 lb., so that for the time being the power requirements could be cared for with the existing equipment.

From the viewpoint of safety, however, and the additional steam generating capacity required, a new boiler plant was a necessity. It was decided to install the boilers in a separate building convenient to the coal siding and to leave space for an engine room, to be added later, equipped with a unaflow-engine generating unit taking steam at 150 lb. pressure and superheated 150 deg. F., this being made possible by the installation of superheaters at the time and the motorizing of the plant.

Records of Coal and Water Consumption Taken

To arrive at the requirements and incidentally determine the economy of the older plant, complete records were taken on coal and water for six days. From the results given in Table I, it was found that two 1,500-sq.ft. boilers operating at 50 per cent overload would carry the maximum day load and one of the boilers would carry the night load. To give some reserve for cleaning and repairs, it was decided to install three boilers of this size with space for a fourth which might be needed some time in the future.

TABLE II—COMPARATIVE COST OF NEW PLANT WITH RETURN-TUBULAR AND WATER-TUBE BOILERS

Items	R. T. Boilers	W. T. Boilers
Building	$20,000	$20,000
Smokestack and foundation	5,000	5,000
Boilers	6,000	12,000
Boiler settings	3,600	6,000
Stokers and fans	5,000	8,000
Water softener	3,000	3,000
Pumps	2,000	2,000
Piping	3,000	3,000
Coal handling	4,400	4,500
Miscellaneous (including engineering)	4,000	4,000
Total	$56,000	$67,500

TABLE III—ANALYSIS OF WELL WATER

Silica	0.05
Iron and aluminum alloys	0.05
Calcium carbonates	7.50
Magnesium carbonates	5.15
Calcium sulphates	0.00
Magnesium sulphates	5.28
Total incrustating solids	18.03
Sodium carbonates	0.00
Sodium sulphates	1.25
Sodium chlorides	2.30
Organic and undetermined	0.12
Total non-incrustating solids	3.67

Fire-Tube Boilers Chosen

In choosing between water-tube and fire-tube boilers, it was considered that the latter, for the size and pressure under consideration, would be preferable, owing to the lower first cost, the low maintenance and an evaporating efficiency comparable with that of the water-tube boiler. Three 18-ft. by 72-in. boilers were therefore installed and equipped with underfeed stokers, this type of stoker being preferred for the lake coal available to the plant.

For the load under consideration two water-tube boilers would have been necessary, each containing 3,000 sq.ft. of heating surface. This size of unit would have been too large for the light load, particularly during warm weather, and the cost of the installation would have been considerably more, with no increase in efficiency or saving in labor. In addition 50 per cent of the equipment would have been idle as compared to 33⅓ per cent in the case of the return-tubular boilers.

Table II gives an estimate of the relative costs of the two types of plant. It will be seen that the invest-

TABLE I—OPERATING DATA FROM THE OLD BOILER PLANT

Date	Coal Days 9 Hr., Lb.	Coal Nights 15 Hr., Lb.	Total Coal, Lb.	Total Ash, Lb.	Water Days, Lb.	Water Nights, Lb.	Total Water, Lb.	Lb. of Water Evap. per Lb. Coal Fired	Per Cent Ash in Coal
November, 20	13,200	10,000	23,200	3,336	89,500	60,000	149,500	6.45	14½
November 21	12,800	11,000	23,800	3,527	97,000	75,000	172,000	7.22	15
November 22	12,300	10,600	22,900	3,470	83,500	64,000	147,500	6.45	15
November 23	12,400	12,000	24,400	3,323	74,200	69,500	143,700	5.9	13½
November 24	12,000	10,000	22,000	2,989	106,000	72,300	178,300	8.1	13½
November 25	12,000		12,000	2,276	94,700	.....	94,700	.....	18½

ment for a water-tube boiler plant would have been $11,500 more than for the plant using horizontal return-tubular boilers, the excess being taken up by the boilers, the settings and the stoker and fan units.

The boilers were placed in a masonry and steel frame building measuring 40x45 ft. in plan and of sufficient height to give plenty of headroom, where a monitor roof was provided to give light and ventilation to relieve any concentration of heat. At the end of the boiler room a mezzanine floor accommodates the top portion of the water-treating equipment and a locker room with shower bath and toilet facilities.

To provide good combustion space the boilers were set 8 ft. 6 in. from the floor to the bottom of the shell, the average distance from the grate to the shell approximating 5 ft. Forced draft is supplied by one fan unit. Regulation of the coal and air supply is effected by a damper regulator operated from the steam pressure, with a setting for minimum capacity at about one-half load. For economical reasons it was not desired to slow down the fan or stoker below this point.

Exceptional Equipment of Plant Instruments

For its size the plant is unusually well equipped with instruments. An orifice meter and speed counters on the feed pumps measure the water to the boiler. Recording pressure gages have been placed on the high-pressure line from the boilers, and low-pressure service to the tannery and on the vacuum returns from the process use of exhaust steam. Other instruments are a recording thermometer on the feed water, a CO_2 recorder used on any one of the three boilers and a three-in-one draft gage on each boiler. Feed-water regulators control the supply of water to the boilers.

As the coal requirements of from 10 to 14 tons a day approximate 4,000 tons a year, a coal-handling system was warranted. This consists of a track hopper with a shaker feed into a vertical bucket elevator discharging onto a reversible drag conveyor above an overhead steel bunker sealed from the boiler-room space. When the incoming coal exceeds the bunker capacity, provision is made to chute the excess supply from the end of the conveyor to outdoor storage. This storage coal is reclaimed by hand. The conveying equipment is driven by motors and the circuits are so wired that when one motor stops, all stop. This provision has been made so that the system will operate without much supervision from the one man operating the entire plant. To reduce his labors further a steam-jet vacuum system removes the ash. The discharge is against a movable target on the premises, as the ashes are used for filling purposes.

Water for Operation Is Obtained from Deep Well

The plant is unique in that it has no city water connection and no outside source of power. The water is obtained from a well on the premises 1,100 ft. deep and is raised by a compressed-air system operating at a pressure of 80 lb., making delivery directly to an overhead tank having sufficient head for the process work and all other uses except the sanitary requirements on the top floor of the tannery, and these are taken care of by a small pump.

Returns from the process work in the tannery are brought back to the boiler house, but as the makeup water must come from the well and this supply is too hard for boiler use, a hot process system has been installed to soften the water. From the analysis given in Table III it will be seen that the water contains over 18 grains of incrusting solids per gallon and 3.67 grains of non-incrusting solids. With the proper lime-and-soda treatment the scale-forming matter is reduced to $2\frac{1}{2}$ grains per gallon, so that little scale-forming matter is allowed to enter the boilers.

Boiler and stoker efficiency now averages from 70 to 72 per cent as compared to 58 per cent in the old plant. This means a reduction of around 700 tons of coal per year based on a previous consumption of 3,700 tons. At $6 per ton delivered, this amounts to $4,200.

With the underfeed stoker it has been possible to burn screenings instead of mine run at a cost of about 75c. per ton less. Owing to the coal- and ash-handling equipment the services of one man on the day shift have been eliminated as well as the employment of yard men to unload the coal. These various items bring the total annual saving to approximately $10,000, which is 45 per cent on the investment for fuel and $16\frac{2}{3}$ per cent on the cost of the new plant.

MECHANICAL EQUIPMENT IN NEW BOILER PLANT OF FORSYTH LEATHER COMPANY

Boilers—3, h.r.t., 18 ft.x72 in.	Freeman Manufacturing Co.
Stokers—3, Type E, 30 sq.ft. grate	Combustion Engineering Corp.
Fan, forced draft, ¾ housing	Clarage Fan Co.
Drive for fan, two 5x6 in. vertical engines	Clarage Fan Co.
Stack, steel 4 ft. diam., 125 ft. high	Advance Boiler & Tank Co.
Pumps, boiler feed, two pot valve	Dean Bros. Co.
Pump, vacuum, one—10x12x16 in.	Union Steam Pump Co.
Coal handling; track hopper, bucket elevator, drag conveyor, 25 tons per hour	Jeffrey Manufacturing Co.
Ash handling, vacuum, steam jet system	Brady Conveyors Corp.
Water softener, Vater hot process, 18,000 lb. per hour	Power Plant Specialty Co.
Boiler trimmings	Lunkenheimer Co.
Soot blowers, front end	Vulcan Soot Cleaner Co.
Feed-water regulators and pump governors	S. C. Regulator Co.
Water columns	Reliance Gauge Column Co.
Steam traps	Boylston Steam Specialty Co
Safety valves, high lift, outside spring	Crane Co.
Stop and check and other steam and water valves	Lunkenheimer Co.
Blowoff valves	Everlasting Valve Co. Eckenroth Valve & Mfg. Co.
Orifice meter on feed water	Cochrane Corp.
Damper regulator	National Regulator Co.
Recording pressure and vacuum gages	American Schaeffer & Budenberg Corp.
CO_2 recorder	Jos. W. Hays Corp.
Draft gages, 3 in 1	Foxboro Company, Inc.
Air compressor, 12x10x10 in.	Ingersoll-Rand Co.

In the past the 60-cycle converter was considered somewhat less reliable than a motor generator; but it is now as reliable as the 25-cycle converter, and both compare favorably with the motor-generator set as to reliability. The insulation of a converter is less likely to failure than that of a motor generator, as the converter is necessarily a low-voltage machine, while the motor generator would usually be wound for full line voltage. A flash-over at the commutator is more likely to occur on a converter than on a motor-generator set, although under proper design this is seldom experienced.

In America, a pressure of one atmosphere is taken as 14.7 lb. per sq.in. This often leads to a misapprehension in reading German and French technical literature, in particular steam tables and diagrams, where pressures are frequently given in "atmospheres." It so happens that the metric unit for pressure, the kilogram per square centimeter, is 14.22 lb. per sq.in. Being a possible barometric pressure and not far from the normal, the French and Germans find it convenient to standardize the atmosphere for engineering purposes at this value.

Preliminary Findings in Refractory Investigation—Part II

Raw Materials, Preparation and Manufacture of Boiler Furnace Refractories

By P. D. HELSER† and G. A. BOLE‡

IT WAS found in the course of the visits to the power stations that many users were not thoroughly familiar with the various kinds of raw materials entering into, and the methods of manufacture of, boiler-furnace refractories. It was thought, therefore, that a brief discussion of these points would be helpful.

The discussion that follows is not intended to be a complete treatise on the subject, but aims to present in a concise form the principal known facts.

A LITTLE over a year ago C. F. Hirshfeld, Chief, Research Department, Detroit Edison Company, initiated an extensive investigation into the whole refractory situation so far as it concerns boiler furnaces. The active co-operation of the Bureau of Mines and of eighteen companies operating central stations was enlisted. A progress report has recently been made, of which this is the second section. An abstract of the first section—dealing with the factors causing failure of refractories—appeared in the August 18 issue.—Editor.

The clays of principal importance in the manufacture of refractories are known as flint, plastic and siliceous fireclays. The most important deposits of flint and plastic fireclays occur in western and central Pennsylvania, New Jersey, northern Maryland, southern Ohio, eastern Kentucky, eastern Missouri and central Colorado. The siliceous fireclays are best represented by those of New Jersey and Georgia.

A. Flint Fireclays—These clays approximate kaolinite ($Al_2O_3 2SiO_2 2H_2O$) in composition, namely, 46.3 per cent silica, 39.8 per cent alumina and 13.9 per cent water, with the best of them running slightly higher in alumina. They are very hard and dense and break with a sharp angular fracture having a fairly smooth surface. On weathering, the clay breaks down into small angular pieces that have no apparent plasticity. Even after wet grinding the plasticity is comparatively low. The clays known as semi-flint fireclays closely resemble the flint type with the exception that, on weathering and wet grinding, the semi-flint type develops a limited plasticity. The drying shrinkage of flint clays, when ground and mixed with water, is very slight, whereas the burning shrinkage is fairly high and varies with clays from different localities. The best flint fireclays have a fusion point[1] of from cone 33 to 35 (3,128 to 3,191 deg. F., revised scale). The fusion point of the best semi-flint fireclays ranges from cone 30 to 33 (3,038 to 3,128 deg.).

B. Plastic Fireclays—These clays range in composition from about 50 to 70 per cent silica and up to 35 per cent alumina. They are comparatively soft and compact and have a "slickensides" structure. On weathering or simply working with water, the plastic properties are highly developed. These clays, however, vary considerably in plasticity. The drying and burning shrinkages are usually fairly high. The fusion point of the best clays of this type ranges from cone 30 to 33 (3,038 to 3,128 deg.); of some very good plastic clays, cone 26 to cone 30 (2,912 to 3,038 deg.); and of the least refractory varieties, cone 15 to cone 26 (2,606 to 2,912 deg.). Most of the deposits occur with coal formations, either associated with flint fireclay or somewhat higher in the geologic series.

C. Siliceous Fireclays—These clays contain approximately 70 per cent or more of silica, a considerable amount of which is present as free silica in the form of quartz sand. The siliceous clays possess less plasticity and bonding strength in the dry state than the more aluminous ones and also a low drying shrinkage. The firing shrinkage is very low and sometimes nil due to the expansion of the quartz. The fusion point ranges from cone 28 to cone 31 (2,975 to 3,065 deg.).

The impurities usually occurring in fireclays used in the manufacture of boiler refractories may consist of one or all of the following: Iron, lime, magnesia, titania and the alkalies. When refractories are used at temperatures close to their softening point, the presence of only one or two per cent of total impurities may cause failure due to their fluxing action.

Special Refractory Materials

Some materials that have been of more limited application in the manufacture of boiler-furnace refractories are: Diaspore, bauxite, kaolin, and silicon carbide. The principal source of diaspore is Missouri; of bauxite, Georgia, Alabama and Arkansas; and of kaolin economically suitable for use in refractories, South Carolina, Georgia and Florida. Silicon carbide is produced synthetically.

A. Diaspore (Essentially AlO(OH) *or* $Al_2O_3.H_2O$.)—This material is used for its high alumina content, which varies from 55 to 75 per cent with a silica content of from 4 to 12 per cent. The ferric oxide ranges from 1 to 2.5 per cent. A substantial portion is

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[1] In this part (II) of the report by Messrs. Helser and Bole the term "fusion point" is used instead of "softening point" as was used in Part I. There is not a standardization of the use of these terms. The ceramists seem to prefer fusion point.

calcined before use because of its large contraction upon heating. The fusion point ranges from cone 39 to cone 41 (3,416 to 3,578 deg.). The fusion point of pure alumina is 3,677 deg. (revised scale).

B. Bauxite (*Essentially* $Al_2O_3.2H_2O$)—This material and bauxitic clays, like diaspore, are used for their high alumina content which varies from 45 to 56 per cent with a silica content of from 2 to 10 per cent. Bauxites much higher in alumina would not be economically suitable for use in refractories. The ferric oxide ranges from 1.5 to 22 per cent. Bauxite must be calcined before being used because of its high shrinkage upon heating. The fusion point ranges from cone 35 to cone 39 (3,191 to 3,416 deg.).

C. Kaolin (*Essentially* $Al_2O_3.2SiO_2.2H_2O$)—Kaolins are comparatively soft and light in color. Only the secondary (transported) kaolins are economically feasible for use in refractories. Some kaolins are only slightly plastic, whereas others possess a high degree of plasticity. The drying and burning shrinkages are high. The fusion point ranges from cone 33 to cone 35 (3,128 to 3,191 deg.).

D. Silicon Carbide (*Essentially* SiC)—This is produced by the union of silicon and carbon into a crystalline structure under the heat of the electric arc at about 3,340 deg. Fusion or softening does not occur below this point though under actively oxidizing conditions decomposition occurs to a certain extent. It decomposes at approximately 4,060 deg. These refractories have high thermal conductivity, low coefficient of expansion and high rigidity and mechanical strength.

Method of Manufacture and Influence on Properties of Ware

A. Flint-Clay Refractories—In making flint-clay-brick the clays commonly used are flint, plastic and calcined (preburned) clay. The calcined clay, which is commonly known as "grog," is usually made by preburning a portion of the flint clay. This is done because of its high firing shrinkage. In general, the function of the flint is to impart refractoriness and low-drying shrinkage; that of the plastic clay is to give strength and toughness; and that of the calcined clay is to lower both drying and burning shrinkage and thus minimize the tendency of the brick to crack or warp during drying and burning. The proportions in which the three types of materials are used depend upon the type of ware to be made. A large number of manufacturers use their "bats" (broken brick and culls) only for the calcined portion of the batch and have no standard mixture. Often no calcined clay is used, while in some types of ware as much as 50 per cent is used. In the best grades of ware only sufficient plastic clay is used to bond the nonplastic clay, unless the plastic clay is of unusually good quality.

Some manufacturers weather their clay and some do not. If weathered, there is less plastic clay required to bond the flint clay, which results in a more refractory product. Or, using the same amount of plastic clay, the ware fires more dense and shrinks more at a given temperature.

In the best practice the clays are usually ground separately in a dry pan, screened through a 12- to 20-mesh sieve and tempered with water in a pug mill or wet pan, usually the former. Where the original grinding is done in a wet pan, the tempering is done at the time of grinding. The greater the water content the greater the drying shrinkage and warpage. The finer the grinding the more dense will be the ware.

When a portion of the flint clay is calcined, in the best practice the calcination temperature is carried to at least as high as the temperature to which the ware is to be fired. This material is then crushed to pass ¼-in. to ⅛-in. mesh screen with a goodly percentage of fines depending upon the physical nature of the calcined material. The finer the grog (calcined material) used, the denser, stronger and more resistant to the action of fluxes will be the resulting product. For such bodies it has been found in good practice that 50 per cent of the fines should pass 80 mesh, but for bodies which are to withstand sudden temperature changes, not more than 25 per cent should pass 80 mesh.

Flint-clay bricks are made either by hand or by machine. The clay for hand-molded ware is usually ground and tempered in a wet pan. The ware is partly dried on a hot floor to a leather-hard condition and then re-pressed by hand. Practically all shapes are hand-molded. The hand-made bricks resist sudden temperature changes better than machine-made because of the greater density of the latter.[2]

Machine-made brick are either power-pressed, made on a soft mud machine or dry-pressed. The clay for power-pressed ware is mixed and tempered in a mixer, extruded through the die of a piston press or auger machine, wire cut and re-pressed in a power press. Some manufacturers re-press the ware twice, there being an intermediate "trimming" operation in which the brick "blanks" are cut to a definite size before being given the final re-pressing. This is a great aid toward the production of brick of uniform size. In some cases the brick are partly dried on a hot floor and re-pressed by hand. The clay for ware made on a soft mud machine is prepared and shaped like clay for power-pressed ware, but the ware is not re-pressed. The clay for dry-pressed ware is ground in a dry pan with a small amount of water and pressed into brick on a dry-press, four to six being pressed at a time. Machine-made brick are much denser than hand-molded ware and are generally truer in shape and size. Of the machine-made brick, the dry-pressed type has the greatest resistance to sudden temperature changes because of high porosity. By the same token the resistance to slag and to load at elevated temperature is comparatively low.

The brick are either dried on hot floors which are heated by live or exhaust steam, or they are dried in tunnel driers heated by waste heat from kilns or by direct fire. Too rapid drying produces strains which may result in cracks or warpage during firing.

The brick are usually fired in round or rectangular down-draft kilns to from cone 2 to cone 12 (2,138 to 2,498 deg.) in from 4 to 10 days. The firing temperature in the best practice is such as to reduce the volume practically to constancy. This insures against appreciable additional shrinkage in service.

It is practically impossible to secure a uniform temperature in all parts of a kiln. Therefore the bricks in various parts of the kiln will be subjected to varying heat treatments. Although all the brick when set in the kiln are exactly the same size, when removed they may vary considerably.

The color of the bricks can often be varied almost at will by varying the atmosphere, reducing or oxidizing.

[2]These general statements apply when the *same flint clay* body mixtures are considered in every case.

in the kiln at the end of the burn. A reducing atmosphere by reducing the iron oxides will bring out a brown color and an oxidizing temperature will have the opposite effect. The color of the bricks, therefore, cannot ordinarily be used as a reliable indication of their quality.

Firebrick should not be exposed to the weather, especially freezing and thawing. Care should be taken to protect the corners and edges, the presence of which materially increases the life of the brick as the "skin effect" of the surface is preserved.

The fusion point of No. 1 flint-clay refractories is usually not lower than cone 31 (3,065 deg.). The lower grades may run as low as cone 28 (2,975 deg.)[2]

First-quality ware, when subjected to a load of 40 lb. per sq.in. should not compress more than 5.5 per cent when heated to 1,350 deg. C. (2,462 deg. F.) in 4½ hours and held at that temperature for 1½ hours. Brick, when fired to a higher temperature, de-form less than when fired lower.[4]

When heated, in an unloaded condition to 1,400 deg. C. (2,552 deg. F) for 5 hours the permanent contraction of such refractories should not be over one per cent nor the permanent expansion over 0.5 per cent of the original length.[4]

In general, the thermal expansion is lower for porous and higher for dense materials, which accounts for the comparatively poor resistance to spalling of dense refractories. Flint fireclay products in general have good resistance to spalling, but this quality decreases rapidly with an increase in the plastic bond clay content and the resulting density. This type of refractory has rather poor resistance to slag action due to its porosity, which varies from 20 to 30 per cent. A higher firing temperature or increase in plastic-clay content improves this property and that of resistance to abrasion.

B. Plastic-Clay Refractories—In general, what has been said of the method of manufacture of flint-clay refractories will apply equally well to this class with some few exceptions. There is little or no flint clay used and the ware is generally machine-made (auger usually). The firing is usually done at from cone 4 to cone 8 (2,210 to 2,354 deg. F.).

Properties of Plastic-Clay Refractories—The fusion point should not be lower than cone 26 (2,912 deg. F.). The lower grades may run as low as cone 19 (2,750 deg. F.).[3]

Inasmuch as brick of this type are not used in service requiring hot load-carrying capacity, no load-resisting requirements are made. Brick seldom fail from this cause when only one face is exposed to the heat.

On reheating to 1,290 deg. C. (2,354 deg. F.) for 5 hours, there should not be a permanent shrinkage of more than 1.5 per cent nor a permanent expansion of over 1 per cent of the original length.[3]

This type of ware is much more dense and hard than the flint-clay type, the porosity running as low as 10 per cent. The thermal conductivity and expansion are greater than for better-quality refractories and the resistance to spalling is less. The resistance to slag action is limited by the softening temperature, but where the time of exposure is short, as in steel-ladle service, the low refractoriness is not serious.

Siliceous-Clay Refractories—Inasmuch as the siliceous clays are usually more plastic than the flint-clay mixtures, the brick are ordinarily made on an auger machine, soft-mud machine or made direct on hand re-presses. The ware is fired to about cone 8 (2,354 deg. F.).

The fusion point of siliceous-clay refractories should not be lower than cone 28 (2,975 deg. F.).[5] When heated to 1,350 deg. C. (2,462 deg. F.) under a load of 40 lb. per sq.in., the compression should not exceed 4 per cent.[6] On reheating to 1,400 deg. C. (2,552 deg. F.) for 5 hours, there should not be a permanent contraction or permanent expansion of over 0.5 per cent.[6]

The porosity may vary from 20 to 28 per cent. The thermal conductivity and thermal expansion are fairly high. The bricks resist spalling poorly and have low resistance to slag action unless the slag be acid in character. The compressive strength about equals that of flint-clay brick, but the toughness and resistance to abrasion are less.

D. High-Aluminous Refractories—These refractories are made from either diaspore or bauxite, bonded with clay or with finely ground diaspore or bauxite. From 25 to 33⅓ per cent of the diaspore is calcined to from cone 14 to cone 20 (2,606 to 2,786 deg. F.) in order to reduce to constant volume. A calcination temperature of from cone 24 to cone 26 (2,894 to 3,002 deg. F.) is necessary to reduce the volume of bauxite to constancy. In each case the calcination temperature required depends largely on the content of impurities present, chiefly silica and iron oxide. The bauxite and diaspore are crushed to pass a 3- to 4-mesh screen. If clay is not used as the bond, a portion of the finely ground raw material is used instead. After wet-pan treatment of the batch the ware is usually formed by the dry-press process. The firing is done at from cone 14 to cone 18 (2,570 to 2,714 deg. F.).

The fusion point of high-aluminous brick will range from cone 34 to cone 38 (3,164 to 3,362 deg. F.). The ware, however, shows considerable deformation under load at elevated temperatures. The thermal conductivity is about twice that of fire-clay brick and the thermal expansion is somewhat less. The strength, toughness and resistance to abrasion are fairly high.

E. Silicon Carbide—The crushed crystalline silicon carbide is shaped into brick by dry-pressing without the use of a bond or with clay or tar. When no bond is used, the interlocking of the crystals, when refired in an electric furnace to cone 18 to cone 20 (2,714 to 2,786 deg. F.), serves as the bond. When a clay bond is used, the refractoriness is limited accordingly. The decomposition point of the former is approximately 4,060 deg. F. and the fusion point of the latter from cone 26 to cone 39 (2,912 to 3,416 deg. F.), depending upon the amount and refractoriness of the clay bond.

When heated to from 1,400 to 1,450 deg. C. (2,552 to 2,642 deg. F.) there is no appreciable deformation under load conditions.

The thermal conductivity is several times that of clay firebrick and the thermal expansion much lower. The porosity varies from 15 to 20 per cent. The resistance to slag action is good with neutral and acid slags but poor with basic slags. The mechanical strength is excellent.

F. Kaolin Refractories—The kaolin is calcined to

[2] A.S.T.M. Specification, Vol. 19, Proc. Amer. Soc. Test. Mat., p. 625.
[4] Specification which, while more severe than A.S.T.M. tentative, is well within commercial possibilities.
[5] A.S.T.M. Specification, Proc. Amer. Soc. Test. Mat., Vol. 19, p. 625.
[6] Specification which, while more severe than A.S.T.M. tentative, is well within commercial possibilities.

from cone 24 to cone 26 (2,930 to 3,002 deg. F.) and crushed to pass ¼-in. mesh. Just sufficient plastic fireclay is used to bond the calcined material. The ware is either dry pressed or made on an auger machine and re-pressed and fired to from cone 14 to cone 16 (2,570 to 2,642 deg. F.).

The fusion point is from cone 32 to cone 34 (3,101 to 3,164 deg. F.). The load-carrying qualities are good, as the ware remains rigid up to cone 26 (3,002 deg. F.). When heated to 1,350 deg. C. (2,462 deg. F.) under a load of 50 lb. per sq.in., there is no measurable deformation.

The thermal conductivity is fairly high and the thermal expansion fairly low. The resistance to spalling is good. The bricks are resistant to neutral and acid slags but not to basic slags. They have fairly good mechanical strength and also have reasonably good resistance to abrasion.

Money and Time Saved on Crankshaft Repair

One of the major emergencies of power-plant operation is the breaking of a crankshaft on a large machine, involving, as it frequently does, a heavy expense for repairs and often a still more expensive shutdown. Such an accident occurred about a year ago at the plant of the Worcester (Mass.) Cold Storage & Warehouse Company.

Eleven years ago this plant installed a large vertical double-acting ammonia compressor that had already seen much service in a New Jersey plant. The cylinders, crankshaft and certain other parts were renewed at the time of reinstallation in Worcester. The two ammonia cylinders (18-in. bore by 32-in. stroke) received their power from horizontal, tandem Corliss cylinders, 21-in. and 42-in. bore by 32-in. stroke.

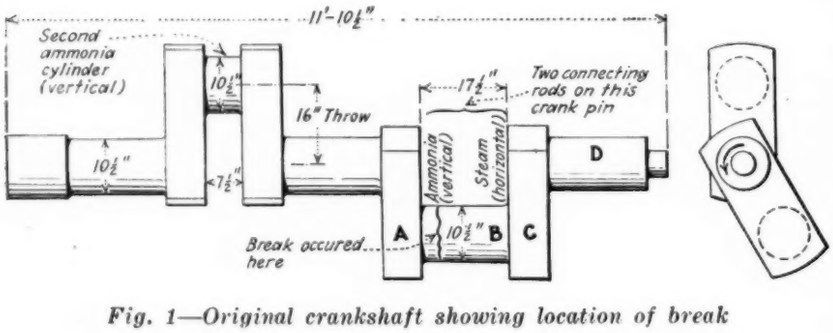


Fig. 1—Original crankshaft showing location of break

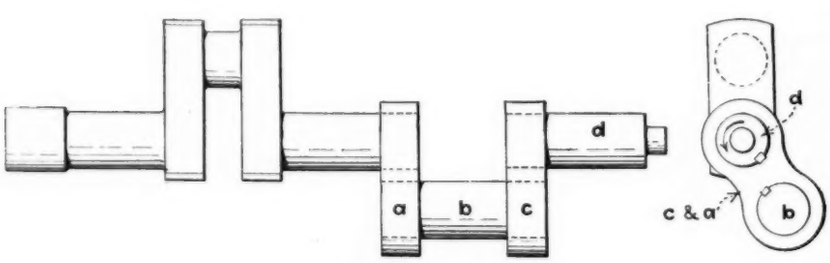


Fig. 2—Crankshaft, repaired as shown, was back in plant one week after broken shaft was shipped out

As may be seen from Fig. 1, there were only two cranks on the crankshaft, one of the pins accommodating the connecting rod to the steam cylinders as well as that to one of the ammonia cylinders.

The compressor ran eleven years without crankshaft trouble, but on May 28, 1924, the middle bearing began to "weave" perceptibly. To stop this its quarter-box was taken up, with the result that the weaving was transferred to the outside bearing on the steam side.

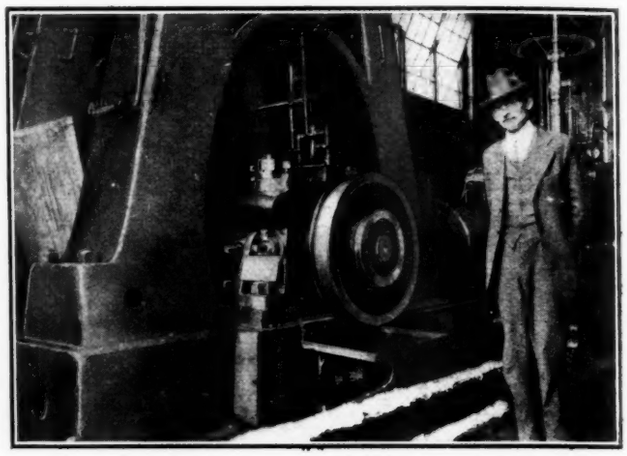


Fig. 3—Robert Johnson, chief engineer, and the ammonia compressor on which repair was made

The machine was shut down and the bearings were taken down on May 29. Investigation showed that the crankpin *B* (Fig. 1) was broken at the point indicated. For the next few days everybody was kept on the jump starting up other ice machines, some of which were down for repairs.

A hurried investigation showed that it would cost $3,000 and take six weeks to get a new crankshaft like the first, so the possibility of repair was considered. Fig. 2 shows the method adopted. On Tuesday, June 10, the broken shaft was loaded on a truck at Worcester. It was driven to a shipbuilding plant on the seaboard, where the section *BCD* (Fig. 1) was discarded and the crank throw *A* cut off, the metal being turned down to form an extension of the shaft at the center bearing. Separate forgings were made for the new throws *a* and *c*, for the crankpin *b*, and the end *d* of the shaft (all in Fig. 2). These were machined with great care and assembled by shrinking and keying. On June 17 the repaired shaft was back in Worcester. The total cost of the repair was $1,500, showing a net saving of $1,500 and five weeks of time.

Seven days after the arrival of the crankshaft the compressor was started. It has been running almost continuously day and night since that time. The photograph (Fig. 3) unfortunately gives only a suggestion of the machine and crankshaft, as it was impracticable to shut down while taking the picture. Standing beside the compressor is Robert Johnson, chief engineer, through whose courtesy the foregoing information was obtained.

Changing Electric Power Source for Elevator Equipment*

By J. A. JACKSON
Industrial Engineering Department, General Electric Company.

WHERE the power supply to electric elevators is changed from direct to alternating current, there are six courses available to meet the new condition. Each of these is discussed in detail along with some of the limitations of alternating-current drives for elevators.

THE present movement in many cities to change over distributing systems from direct to alternating current brings up the question of converting existing direct-current equipment for operation with the other form of power. There are several ways that an elevator can be changed from one source of power to another and the best method in one case may not be the best in another. The various methods are:

1. Installation of an alternating-current motor driving a direct-current generator, making no change in the elevator motors and control.
2. Installation of synchronous converters, making no change in elevator motor and controls.
3. Changing the direct-current elevator motors and control to alternating-current motors and control.
4. Installation of individual alternating-current motor with direct-current generators and use of old direct-current elevator motors (modified if necessary) with variable voltage control.
5. The same as No. 4, but using a new direct-current elevator motor especially designed for variable-voltage control.
6. Where the elevator machines are old, it may be advisable to install a new elevator equipment designed to meet the changed conditions.

In the last analysis the problem boils down to one of economies as well as engineering, although there may be peculiar circumstances, aside from either one, which may influence the choice in some individual cases.

Analyzing the Power Problem

In making such an analysis it should be remembered that the addition of motor generators, for either variable-voltage control or to retain the existing direct-current rheostatic control, adds a rather heavy percentage to the capital investment for the elevator equipment and necessitates carrying more spare units or parts. Also, if the rheostatic control is retained, the power consumption is considerably increased because of the light load losses of the set. Additional floor space is necessary, which may require an enlarged penthouse or the use of rentable space elsewhere in the building. Maintenance charges are increased owing to additional rotating machines and when all the factors are considered it is not difficult to imagine that in many cases modern traction-drive machines designed for use with suitable alternating-current motors, could be put in and show the best economy in the change-over and future operating costs.

Where, on account of high-speed service, a straight alternating-current drive is not applicable, the choice falls between a motor generator or a synchronous converter, with a spare unit for the entire bank of elevators or variable-voltage control with a motor-generator set for each elevator. Where the service and operation of the existing direct-current machines is entirely satisfactory, it is usually best to retain them and to supply one or more motor generators or converters with suitable spares to insure continuity of operation, but if service must be increased and a higher grade of performance is demanded, variable-voltage control must be given preference. This is particularly true for local service elevators as actual tests on two 600-ft. per min. elevators in the same building, one with rheostatic control and one with variable-voltage control, showed that the elevator with variable-voltage control made floor-to-floor stops in 28½ per cent less time than the elevator with rheostatic control, because of the more rapid and smooth acceleration and deceleration and the greater ease in making accurate landings regardless of load in the car.

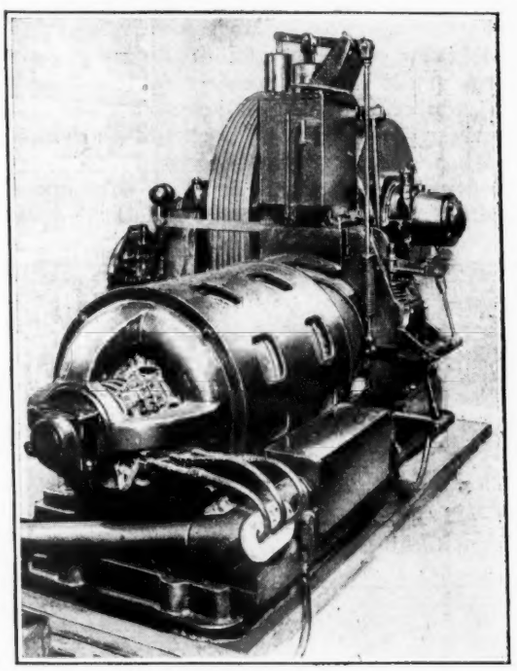


Fig. 1—Alternating-current double motor with a speed range of 3 to 1 on a traction elevator machine

The highest car speed to which alternating-current motors and geared machines can be applied is probably still a debatable question, although it seems to be

*This article is based on a paper presented recently at the Independent Elevator Builders' Convention, held in Hot Springs, Virginia.

generally agreed that they can be successfully applied up to 450 ft. per min., using three-to-four speed ratio motors. Six-to-one speed ratio motors have been applied to higher speeds, but it seems questionable whether a thorough analysis of all conditions, including cost, maintenance, speed regulation, rates of acceleration and deceleration, speed control, etc., would not show that a geared or gearless direct-current motor with variable-voltage control supplied from an alternating-current direct-current motor-generator set to be a better proposition from every viewpoint except perhaps first cost, and that this increase would be more than justified by the reduced maintenance and superior service of the variable-voltage equipment.

New Types of Alternating-Current Motors

Electrical manufacturers are now investigating new types of alternating-current motors for elevator drives, including motors with fixed-speed ratios and also motors of the variable-speed type, giving a smooth and gradual speed change over a three-to-one speed ratio similar to the speed change obtained from an adjustable-speed shunt motor. It is too early to predict what may come of these investigations, but it is of interest that the electrical industry is very much alive to the fact that improvements in alternating-current drive are much to be desired and are working to accomplish this result. The same thing may be said of alternating-current control equipment, and it seems safe to predict that the next year or two will see some decided improvements in these devices, giving much smoother operation with existing types of motors.

Power companies, desiring more efficient operation, are insisting upon higher power-factor loads. Hence,

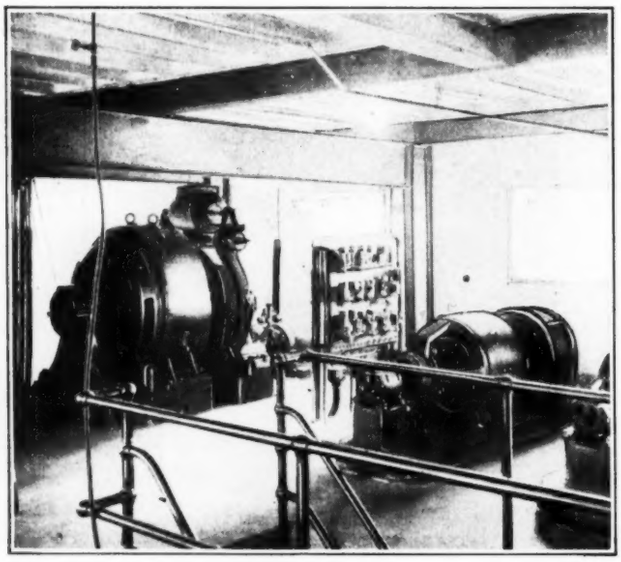


Fig. 2—Variable-voltage controlled gearless elevator

where large motor generators are necessary for large banks of elevators using rheostatic control, synchronous motors may be used which will permit operation at unity power factor—or even at a leading power factor, if oversize motors are used. Synchronous motors are not so well adapted to the small motor generators used with variable-voltage control, as they are special machines and therefore expensive and require more complicated starting equipment and higher skilled labor to handle them. With these small sets driven by induction motors, and also with direct alternating-current driven elevators, the possibility of using static condensers, now known by the trade name of "capacitors," presents itself for the correction of power factor. The capacitor has no moving parts and may be connected directly across the terminals of the machine on which the power factor is to be corrected, or a single

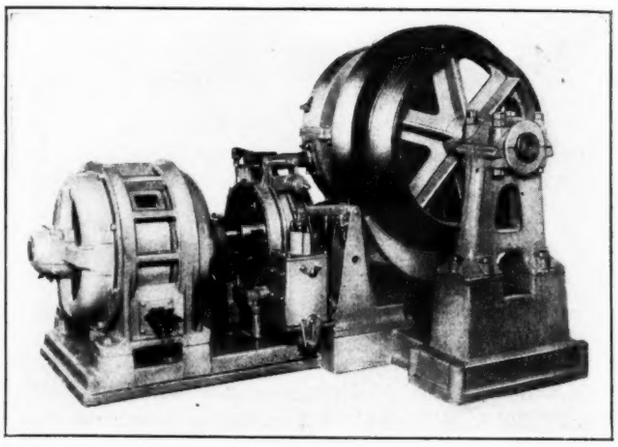


Fig. 3—Traction-type elevator machine driven by a 2-to-1 speed alternating-current motor

capacitor of larger size may be used for a bank of motors. It is a somewhat new development and, hence, rather expensive at present, but its maintenance charges are practically nothing and some power companies offer sufficiently more attractive rates for a high-power-factor load to justify the extra investment.

Flickering of Lights When Elevators Are Started

Flickering of lights when throwing elevator motors on the line is another aggravating problem which occasionally arises, particularly with alternating-current motors, where the lights are fed from the same transformer as the elevator motors. This trouble may come from any or all of several causes, such as too small transformers or transformers with poor regulation, too little copper in feeders, poorly designed motors taking too much starting current, incorrectly laid out control equipment, or too small generator capacity where an isolated generating plant is used. The utmost care should be taken to prevent this trouble when laying out and installing the equipment, as money spent at the start to prevent trouble is a much better investment than the same amount spent to correct a later, aggravating complaint.

The noise problem is perhaps the most elusive and most aggravating one to solve, due largely to the fact that noise is relative only and there is no fixed standard by which it may be judged. An equipment that might be entirely satisfactory in one building might be unsatisfactory in another of the same general type, as a result of the construction, the class of tenants, the difference in the quality or character of the noise, or even the extraneous noises existing in the vicinity of the two buildings. Also, an owner may be entirely satisfied with his installation until he happens to inspect a somewhat similar and quieter equipment in another building when he may become dissatisfied, probably

losing sight of the fact that the installation inspected represents the latest development in the art while his equipment may be several years old and may have represented the best installation that could be made with the knowledge at hand when it was installed.

Noise from Elevator Motors

Noise complaints are more likely to arise with alternating-current motors than with direct-current motors, as the former have a rapidly varying magnetism while the latter have a magnetism of fixed value. The varying magnetism of an alternating-current motor produces a hum depending in pitch on the frequency that produces it. Also, other magnetic noises occur because of the heavy inrush of current at starting and when changing from one speed to another on a two-speed motor. These noises can be greatly minimized by careful design, and all motor manufacturers are doing their best to reduce them as much as possible, with varying degrees of success. The fact remains, however, that noise is inherent in the alternating-current motor to some extent and, also, that alternating-current control is inherently more noisy than direct-current control for the same reasons. Consequently, more care is required in the pent-house construction and in the foundation, to secure a first-class job.

Particular care should be taken to use a sound insulating material in the foundations for the elevator machine and the control board in steel-frame buildings. Structural steel will transmit noises to remote parts of buildings where they may appear greatly exaggerated owing to the sounding-board effect of the walls and ceiling. Some of the larger concerns manufacturing sound insulating material have made a detailed study of the noise problem in buildings by accoustic engineers and are usually glad to furnish valuable suggestions.

Voltage Should Be Checked on Alternating-Current Motors

One of the first things that should be done on any alternating-current installation is to check the voltage at the motor terminals when hoisting maximum load, when lowering maximum load and at the instant of starting from rest in the hoisting direction with maximum load in the car. Correct voltage under all conditions is of major importance on an alternating-current installation, while of only relatively minor importance on a direct-current equipment. On direct-current, torque is a function of current, while on alternating current it is a function of the square of the voltage. Consequently, if the voltage is 10 per cent low on an alternating-current motor, the torque it will develop is only 81 per cent of its rated torque. If the voltage drops 15 per cent while starting, the starting torque is reduced to 72 per cent of rated starting torque and the elevator may stall.

On a direct-current installation the torque would not be affected under the same condition, although the speed would be somewhat reduced. This situation cannot be helped by putting on a larger motor where the voltage is known to be low, as a larger motor takes a correspondingly larger starting current which tends to pull down the voltage still lower and thus defeats its own purpose. Further, it has a larger WR^2 and thus consumes more power while accelerating and is harder on the brake when stopping.

The best remedy is to insist on a correct voltage supply from the power company, or as a last resort, to supply a motor wound for the existing voltage. Too high voltage may be equally detrimental, as 10 per cent over-voltage produces a starting torque of 121 per cent of rated starting torque which may start the car with too much of a jerk and may also cause excessive noise on both the motor and the control equipment as well as excessive maintenance on the control due to the increased slam of the contactors.

It is important to check the voltage, therefore, under all conditions if any trouble arises and check it at all hours of the day. Tests on actual installations have shown badly fluctuating voltage conditions, being normal and constant at one part of the day and very high or low and fluctuating badly at other hours. If the control is adjusted for smooth operation at one of the extremes, it may be unsatisfactory at the other, as a variation of 10 per cent below normal to 10 per cent above normal gives the motor a 50 per cent higher torque for the high-voltage than for the low-voltage condition.

Counterweights Influence Size of Motor Required

Another question of much importance is that of counterweighting. It is not for the electrical manufacturer to say what the counterweighting should be for most efficient operation, but what he is vitally interested in is to be sure that the same amount of counterweighting is used as that on which his recommendations were based, when he is asked to estimate the size of the equipment. If he is asked to estimate on 40 per cent. and only 25 per cent counterweight is installed, it causes more heating of the motor, slower accelerating, poorer regulation and other troubles for which the electrical manufacturer should not be held responsible. It is not a difficult matter to check counterweighting, and no doubt some troubles could be eliminated if more attention were given this point.

It also helps greatly in making recommendations if the manufacturer knows, as accurately as possible, the total weight of all moving parts in the elevator system. On one recent installation the total weight actually came 18 per cent greater than the weight given for recommendations, and it was asked that rates of acceleration, power consumption and speed regulation be supplied. The figures were met only because very conservative equipment was used, and it is doubtful whether they would be met on the majority of jobs if such discrepancies existed, as competition usually does not permit such conservatism. The excessive weights were due to the substitution of bronze cars instead of a much cheaper and lighter car after the contract was closed.

Some of the various points mentioned are of importance on either alternating-current or direct-current installations, whether rheostatic or variable-voltage control is used, but they are usually of more importance on alternating-current installations because of the more unfavorable characteristics of these motors in connection with elevator drive.

Filtered cylinder oils are made from the same stock as the steam-refined cylinder oils, but through having been filtered, the heaviest hydrocarbons and the more adhesive ones have been removed. This makes the oil translucent instead of opaque as are the non-filtered steam-refined oils.

Glimpses of Havoc Wrought in Power Plant by the Earthquake at Santa Barbara

The picture above seems to bear out the contention of some that the ground moved back and forth, then heaved up. The edge of this ten-ton transformer was originally in position 1. It then apparently slid to position 2; then to 3; and finally was projected to the position shown

Photos by Fauldings

Although the roof and walls of the building suffered heavily and partly buried the boilers in débris, the steam piping, owing to its flexibility, was little damaged

This 42-in. Newman foot valve has an overall diameter of 7 ft. 7 in., is 11½ ft. high and weighs 12 tons. It is claimed to be the largest of its kind made

International Newsreel

This cooling tower which serves the Berlin Municipal Plant handles over two million gallons of condenser circulating water per hour

Photo by W. C. Foster

Relief valve discharging at Oak Grove (Portland, Ore.) power house. The jet which is 40 in. in diameter is discharging under a head of 870 ft. and represents in energy 35,000 hp.

Reducing the Power-Plant Water Bill

By Theodore Blauer

AMONG marine engineers the conservation of fresh water has long been recognized as an important factor in the reduction of engine-room charges. On the other hand in stationary plants where an ample

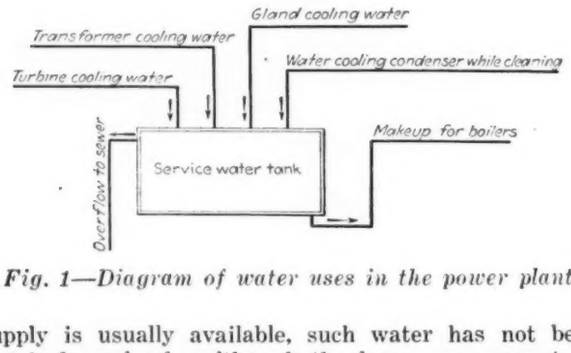


Fig. 1—Diagram of water uses in the power plant

supply is usually available, such water has not been watched so closely, although the losses may mount up to many dollars annually.

With modern steam turbines and condensers the use of fresh water has been reduced to within 3 per cent of the total water evaporated. However, this makeup item is often only part of the city water purchased, which is evident when the water bill exceeds the makeup used. This is not surprising when we consider the diagram in Fig. 1, which shows the city water used for various purposes about the plant and the common method of wasting the overflow to the sewer.

In most cases where the amount of fresh water consumed exceeds the amount of makeup, there is room for improvement. In other words, city water less

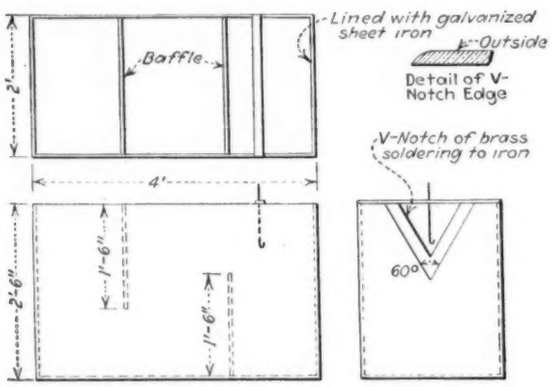


Fig. 2—Simple V-notch weir to measure water flow

makeup × rate per 1,000 cu.ft. = loss in dollars due to excess city water used.

It is not difficult to draw up a definite procedure to determine where the city water is lost and to cut down such loss. Without a program the work would be a long-drawn-out affair, especially in large central stations with their intricate maze of pipe lines.

Pipe lines are changed so often that it is advisable as a first step to make a sketch of all the city water lines from source to consumption throughout the station, tracing down all the small as well as the large lines.

The second step is to measure the city water used at various points; a regular city water meter which has been calibrated is suitable for this work. I have found that a small V-notch tank is very accurate for flows up to 15 cu.ft. per min. For the benefit of those who may wish to construct such a meter, in Fig. 2 is an illustration of the construction of a simple weir tank with baffle plates to break the ripples and eddy currents. The tank can be made of ¾-in. white pine. By lining with galvanized iron and soldering the joints, all chances of leakage are eliminated. At the discharge end it is best to use a special plate having a 60- or 90-deg. angle notch cut into it as shown. The hook can be made of ¼-in. round iron and its points sharpened. The water flowing over the notch can be measured very accurately by the formula $Q = KH^{\frac{5}{2}}$, where H is the head in inches on the weir. The constant K, which varies with the head, can be determined

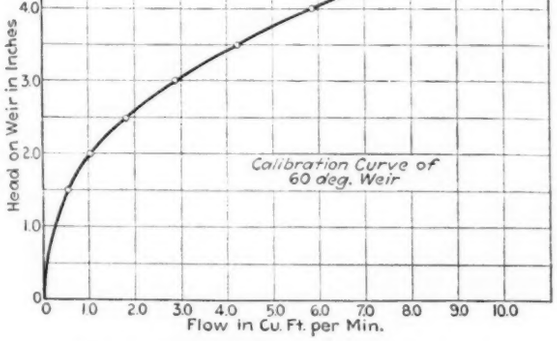


Fig. 3—Typical weir calibration curve

by weighed water passing over the weir at different heights, and a curve constructed similar to Fig. 3. With equipment to measure water available, whether it be an ordinary water meter, a V-notch weir or a venturi meter, the various points in the system at which water is taken from the city lines are tested for the actual amount used. Each point is subject to study whether it can be reduced by suitable changes in the equipment; ingenuity coupled with common sense will usually solve the problem. In actual practice it will be found that excess water is generally used, as excess does no harm except to cause a neglectful waste.

As a third step select from the layout points at which recording water meters of the integrating type can be installed, enabling each watch to ascertain the water it has used. Carelessness on the part of one watch swells the total of city water used for the day, and those who are careful are likely to be discouraged when their painstaking care has yielded no results. To overcome this feature a bulletin board can be used on which is posted daily the amount of city water used per shift. The economy or wastefulness of a watch shows up each day. A friendly rivalry soon ensues, and those in charge of a shift are soon striving to obtain the lowest possible consumption.

There is no excuse for leaving steam pipes bare even for a few months, as a first-class job of heat insulation will pay for itself in from two to six months, depending on temperature, thickness, cost of fuel, etc.

Different Drives for Refrigerating Machines

Choice of Prime Mover for Ammonia Compressors—Examples of Drives Used

By TERRY MITCHELL

SO MANY thousands of refrigerating machines are being installed every year that the selection of the proper type of drive for this class of machinery is becoming of vital interest to engineers.

While electric drive for the refrigerating plant is the most convenient, the service in some places may be unreliable or costly. In making raw water ice, unless an improved low-pressure air system is used, the ice will be rendered opaque if the air pressure fails. This means that the power supply to the air blower must be continuous, day and night, with not more than a few minutes' shutdown at a time. The owners of a certain large ice plant in Pennsylvania, using electric drive, have had to install a boiler and steam engines, for connection to the air compressor and one of the refrigerating machines, because the electric power company could not guarantee them against shutdown periods up to an hour in duration. The power usually went off for some accidental reason; once a man got across the line, another time there was a small fire at the central station, then a storm would make trouble—but a set of big tanks full of ice should not be dependent upon such chances.

Breakdown Power

Other plants make arrangements for auxiliary prime movers of various sorts, for the sake of safety. The Breyer Ice Cream Company's new plant, in Philadelphia, now the largest ice cream factory in the world, has four large vertical ammonia compressors, three of which are direct-connected to synchronous motors; the fourth being driven by a unaflow engine supplied with steam from the plant's own oil-fired boilers. Creameries and industrial plants requiring steam for their regular work, naturally turn to steam as auxiliary power for the refrigerating machines in the event that purchased electrical energy proves to be the cheapest power.

A vertical medium-speed compressor with direct-connected synchronous motor in the plant of the National Biscuit Co., at Buffalo, N. Y., is shown in Fig. 1. Observe that ample space has been left between the motor and the outboard bearing for sliding over the stator, when repairing or cleaning work is to be done. It is important when erecting such heavy motors to see that shims are placed between the feet of the stator and the sole plates, to permit the stator to be lowered when wear in the shaft bearings has decreased the air gap at the bottom of the motor. The tendency in synchronous-motor design is to eliminate the use of flywheels by putting the necessary flywheel weight in the rotor of the machine.

Since the speeds of large ammonia compressors have been increased, the engineer wishing to use steam can choose between steam engines of various types, whereas Corliss engines were the universal selection of former days. Slide-valve steam engines, common at first on medium-sized machines, are now found only in the vertical style of engine direct-connected to small inclosed compressors.

Steam Engines Still Used

Modern steam engines suitable for direct connection to compressors include the unaflow, the counterflow poppet valve and the non-releasing Corliss types. The unaflow is particularly smooth running and efficient when operated at medium speeds. Where compound engines are employed, the high-pressure cylinder is frequently built with the disengaging style of valve motion, which is good for speeds up to, say, 125 r.p.m. when handling poppet valves. For export work, especially to the Tropics, where head pressures on the compressor are high, slow-speed machines are preferable and the Corliss engine is still supreme.

Steam drive is essential for the service of ice plants situated where bad water makes it impossible to manufacture raw-water ice. Distilled water ice can be turned out with success in all cases except where the presence of a peculiar vegetable matter would give the distilled water an unpleasant odor. Clear raw-water ice cannot be produced if sodium chloride is present in any considerable quantities, since no practical method of treatment will change the salt to an insoluble form that can be filtered out of the water. Other chlorides, as calcium and magnesium, and similar sulphates, give the same trouble. Hence distilled-water ice plants will continue to be built, using steam-engine drive.

Waterwheel in Ice Plant

An unusual drive is illustrated in Fig. 4, which shows a large inclosed compressor direct-connected to a 100-hp. waterwheel operating under 127 lb. hydraulic pressure. The installation is in a packing plant for fruit, at Hood River, Oregon. This wheel is of the Pelton type and is made heavy enough to provide its own flywheel effect. Since the load on the compressor is steady, no governor is necessary for the water needle, the speed being regulated simply by the hand-operated valve. The compressor has two 12x12-in. cylinders and turns at 170 revolutions per minute.

A study of oil engines as driving power for refrigerating machines brings out the relative fuel consumption of different types of engines. Thus far, two-stroke-cycle oil engines have been the most popular in ice-making and cold-storage work, as their simplicity makes for the continuous performance required; two-stroke-cycle engines have no valves in the ordinary sense of the word, and there is nothing except the piston and

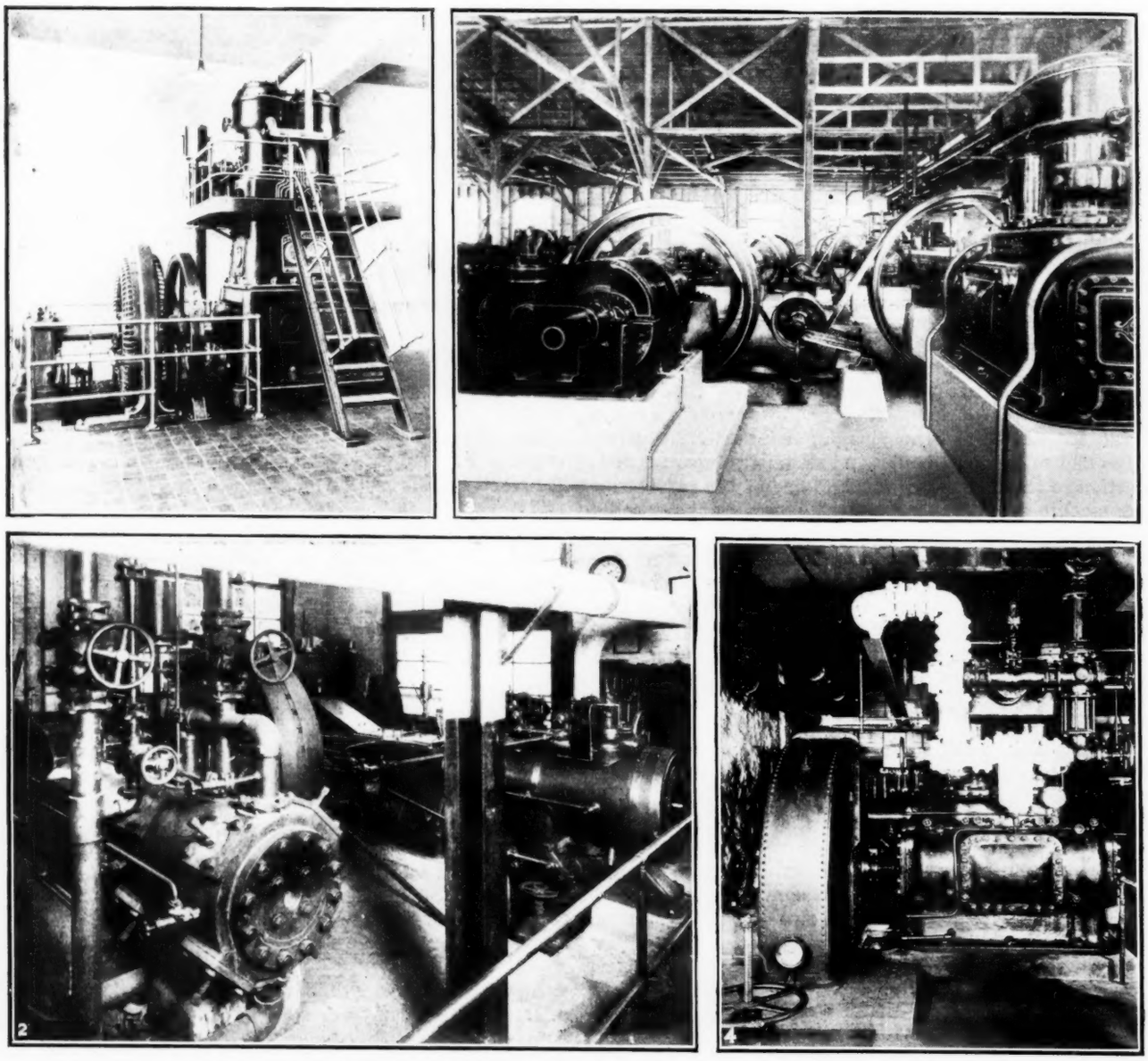
cylinder head to become coated with carbon or "gummed up." The fuel consumption of a two-stroke-cycle oil engine of 50 hp. or slightly larger, may be expected to be around 0.62 lb. per brake horsepower-hour.

With a four-stroke-cycle engine the consumption is reduced to 0.45 or 0.48 lb. This latter type of engine may have to be shut down for a few hours, occasionally, to clean and grind in the valves, but that feature does not always offset the saving in fuel expense. The original cost of a four-stroke-cycle engine is roughly 35 per cent higher than that of a two-stroke-cycle unit of the same capacity and is about twice the cost of a unaflow steam engine.

Short belt drives are becoming more generally adopted every day. With small compressors of the automatic type it is practically necessary to provide an idler pulley to insure the belt against slipping under the heavy starting load. On larger compressors, say those above 20-ton capacity, it is good practice to use double leather belts of extra flexibility.

In cases where it is planned to connect oil or gas engines to compressors through short belts, many engineers feel doubtful of results, owing to the whipping action often present with drives from such engines. The battery of machines shown in Fig. 3 are 12x12-in. inclosed-type compressors driven by 120-hp. horizontal natural-gas engines in the plant of the Crescent Creamery Co., Los Angeles, Calif. The idlers are equipped with dashpots to keep down any jumping of the belts. In this installation the concrete foundations for the compressors and engines were poured in one piece, and the plan has proved eminently satisfactory. A dime can be balanced on edge on an engine cylinder while running under full load, indicating that the machine is well balanced.

Silent-chain and geared drives are far less common



Figs. 1 to 4—Typical ammonia-compressor drives

Fig. 1—Synchronous motor drive. Fig. 2—Compressor is direct connected to a unaflow engine. Fig. 3—Gas engines drive compressors through short belts. Fig. 4—Pelton waterwheel drives one machine

than the belted and direct-connected styles. Chains are often employed when worn-out steam engines are being replaced by electric motors. The compressor shown in Fig. 5 was installed in Baltimore, Md., in 1886, with a Corliss engine drive. After a record of continuous operation until 1920 the engine gave way to the motor and chain. The old compressor is still carrying its daily load satisfactorily and no repairs have been made on the chair

Oil Baths for Gears

The attitude of the builders of silent chains on the subject of oil cases is interesting. Some makers state that they recommend inclosed cases for chains only to keep dirt away from them and for the increased safety the casing affords. Others depend on the tight casing to keep the chain and sprockets lubricated and to reduce noise. The standard speed for silent chains of 1-in. pitch and smaller, is about 1,450 ft. per min.; larger chains may run up to only about 1,200 ft. By the use of oil baths these speeds can be increased considerably, the lighter sizes being run up to 2,000 ft., provided the gear is substantially designed and is carefully erected.

Chains are being used on some of the combined refrigerating machines, though short belts with idler pulleys are more often found on these small units.

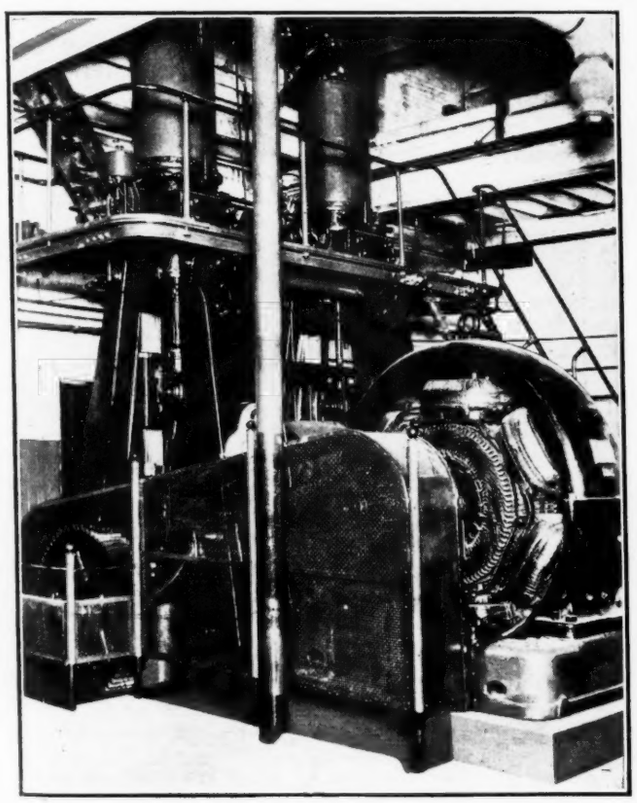


Fig. 5—Motor replaced Corliss engine

Combined machines are so frequently arranged for automatic control or are operated by inexperienced men that this means of maintaining the belt tightness and grip on the pulleys is essential.

The geared machine shown in Fig. 6 is part of a drinking-water system in an industrial plant. This geared arrangement is a saver of space, but the compressor had to be furnished with a special base to accommodate the oil casing, and taken all in all, the drive lacks flexibility. Unless expensive gears and pinions of the highest grade are put on, such a drive will tend to be noisy.

Rope drives are found in a number of the older plants. As some of them have experienced small wrecks when the ropes wore out and broke, the use of a telltale or

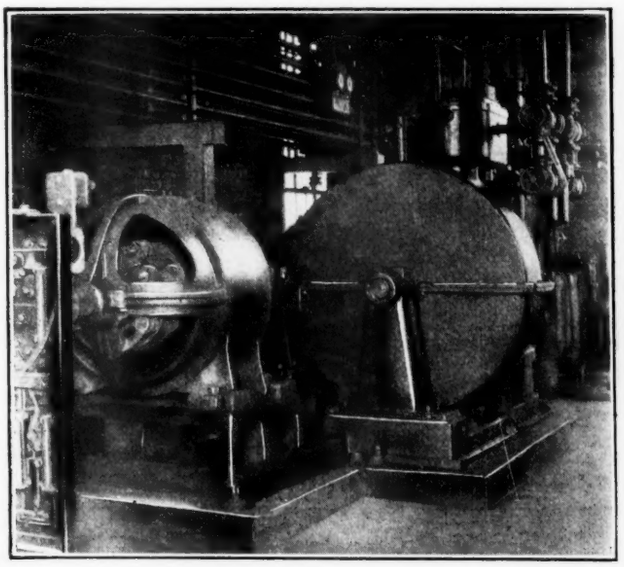


Fig. 6—This gear drive is not recommended

wear indicator is advisable, especially in the American method of rope driving, where a breakage at one point loosens the entire rope drive. For complicated drives the use of ropes has undoubted advantages. In cases where a belt wheel is to be adapted to carrying ropes, a hardwood lagging can usually be added to the face of the wheel, the necessary grooves being turned in the wood after it is fastened in place.

In the operation of powdered-coal furnaces the most important requirement for obtaining the best results is to keep the flames from striking the boiler tubes. The furnace operator should therefore frequently observe the condition of the flame under the boiler tubes. When the flame strikes the tubes, it shows that a large amount of solid particles of unburned coal is passing out of the furnace with the gases and the amount of slag deposited thereon is greatly increased; clogging of the gas passage may necessitate a shutdown. Losses from incomplete combustion and from slag deposits on the tubes are particularly bad if the flames are smoky brown. The best furnace conditions are obtained when only the tips of the flames touch the tubes and the flames are clear and almost transparent. Smoky flames striking the tubes may be attributed to improper adjustment of the air supply, the flames turning up without going down into the furnace, or too high a rate of combustion.—*Bureau of Mines Bulletin No. 237.*

Except in very moist coals the heat loss due to the evaporation of the moisture in the coal is almost negligible, the loss due to the moisture produced by the combustion of the hydrogen being generally much more important.

Boiler Performance Based on Heat Content of Combustion Gases

By W. H. JACOBI†

METHODS of measuring boiler performance have not kept pace with the progress in equipment. Ratios representing heat supplied to the steam per pound of fuel are not desirable on account of the wide variation in fuels and relative air supply. Heat supplied to steam per unit heating surface takes no account of the combustion conditions. On the other hand, all fuels properly burned with the same percentage of excess air produce nearly an equal heat content per unit (pound or cubic foot) of combustion gas, indicating that performance should be based on the latter factor.

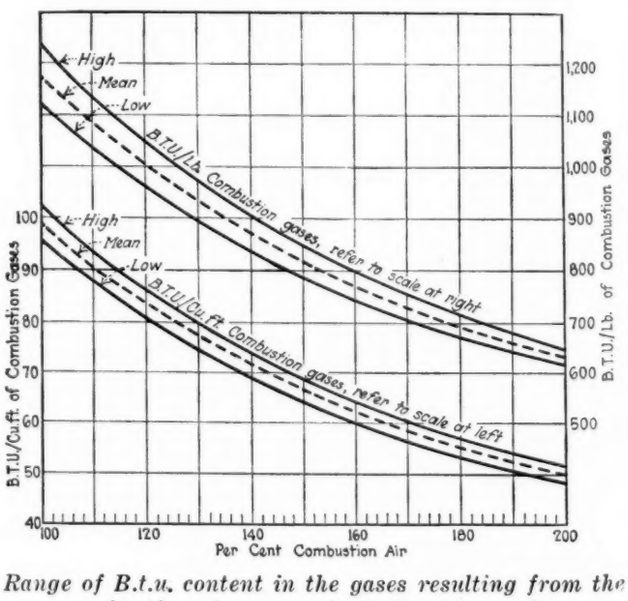
PERFORMANCE based on heat available in combustion gas is readily translated into fuel conditions. This does not unduly penalize the boiler for improper grate performance as when based on boiler heating surface. There is the meaningless boiler horsepower, factors of evaporation, catechisms of rules and of "don'ts," the "per cent of rating" as a measure of boiler capacity, and not yet has even a definition of the determinants of boiler performance been given, to say nothing of the basis for making guarantees to cover it.

Not long ago, based on the commercial input-output method of gaging economy and production, the quantity of fuel burned per unit area of grate was regarded as a fair measure of capacity and performance. This was followed by its near equivalent, "pounds of coal per developed boiler horsepower." The fallacy of this method is manifest. Costly experience not only revealed that a pound of coal was not a pound of fuel, but in succeeding steps indicated that the rate of burning fuel per unit grate area or furnace volume was not so much the index of good performance and economy as to burn it properly; along this line of thought the highest degree of perfect combustion gaged by the amount of carbon dioxide contained in the resulting gases was and still is looked upon as the index of good over-all performance.

On the basis of heating value, to say that so much fuel shall or ought to produce so much steam, is obviously irrelevant and a premise on which no guarantee can be given since fuel may be burned very completely under a boiler and fail to produce the anticipated results, without this outcome being a fault of the boiler, possibly not even of the attending operating skill. If one observes a properly operated boiler setting, especially if well designed, one cannot help being impressed with the uniformity of the fire and of the distribution of gases within the furnace, which condition reveals at once not only thorough combustion, but without question thoroughly mixed and uniformly heated gases before entering the boiler.

Guided by the results, under such conditions, which approximate theoretical anticipations, no doubt guarantees on the performance can be safely given. Accordingly, on the input-output basis with relation to the boiler proper, to state that with a certain rate of combustion gases containing the available heat of the fuel burned flowing through the passes of a boiler, a certain amount of steam may be produced, is not only consistent with the facts, but a surer measure of performance and by far a better basis on which to make boiler guarantees.

On this point it is pertinent to state that as a practical proposition for all cases it is hopeless to expect similarity of results or anywhere near 100 per cent perfect uniformity in the rate of flow or in the heat content of the gases of combustion, nevertheless, an average rate of uniform flow and of heat content of combustion gases is not only possible, but easily obtainable from all kinds of commercial fuels, which closely approach theoretical expectations.



Range of B.t.u. content in the gases resulting from the combustion of commercial fuels with varying amount of air supply

Note that for twelve different fuels, including lignites, coals, oil and gas, correct combustion under any given air condition gives unit gas heat contents varying from two to six per cent from the mean value shown by dotted lines.

The accompanying chart has been prepared to illustrate the heat conditions exhibited by gases of combustion for a wide selection of typical commercial fuels. The table shows the composition and corresponding

* Abstract of paper, "Guarantees on Boiler Performance," presented at the 1925 annual meeting of the American Boiler Manufacturers' Association at Watkins, N. Y.

† With the Springfield Boiler Company.

heating value of the fuels selected. Tabulations were made giving the combustion data for the same fuels with varying amount of air from theoretical requirements to 200 per cent of those requirements. The figure shows in curve form the heat value per pound and per cubic foot according to these calculations. In each case the curves are drawn double to indicate the high and low limits determined by computation. A third broken-line curve interpolated between the other two is also drawn to represent probable average conditions.

The closeness of the results obtained may be taken as an index of uniform heating quality for all commerical fuels with relation to the gases produced and corresponding amounts of air supplied. Besides the closeness of the heating values so obtained for all fuels, the interesting part of the curves so drawn is that they afford a guide to better judgment in estimating the gas conditions likely to develop under particular circumstances applicable to the performance of boilers within the limits indicated by the high and low lines which may be considered also as the limits of permissible tolerance for the results expected from any fuel.

To define boiler performance in terms of uniform flow of combustion gases containing a certain amount of heat value would not only simplify matters and serve to line up all the component parts of a boiler setting into a consistent working whole, but it would have the advantage of being of material assistance in better understanding the function of each component part and in the solution of many problems as well.

Performance and Rate of Gas Supply

The mooted question of furnace design and proper proportioning of stacks will be greatly clarified by the adoption of this "rate-of-gas-supply" measure of performance. Just recently we have begun to measure the merits of furnace operation by the volume per pound of fuel burned or per boiler horsepower developed, which admittedly is too arbitrary and irrelevant. The function of a furnace in conjunction with fuel and air feeding equipment as a producer of properly blended gases suitable for boiler operation has not yet been so stated, and with some confidence it may be said that it is not so understood. In general, it is conceded that a stoker or an oil-spraying nozzle or a gas jet under the name of "burners" is to be credited with the burning of fuels, the furnace being only an accessory.

If instead of just burning or passing through so much fuel per unit grate area or nozzle or jet, the combined fuel-feeding devices and furnace are required to deliver uniformly so many pounds of properly combusted gases containing the highest amount of heat value possible, just so a boiler is required to deliver definite amounts of steam of certain quality, it is unquestionable that we will soon obtain better performances, reliable guarantees and greater compensation for our efforts. Stacks also suffer from arbitrary methods of measurement.

It is needless to say that a great many of bad boiler performances and troubles are due to inadequate draft which invariably reflects poor stack proportions or arrangement. If stacks were designed on the "per-pound-rate-of-gases" produced with relation to the load they must serve, the folly of connecting four or more boilers to one stack and expecting to operate one boiler with a high degree of satisfaction when the other three are down, or operating boilers at nominal rating with a stack designed to take care of 300 per cent rating conditions would be apparent.

In conclusion, it is to be stated that:

a. Our present methods of determining boiler performance and of making guarantees thereon are loose and inconsistent.

b. If guarantees must be made to cover the merits of boiler equipment, of necessity there must be a consistent working plan on which to base these merits and corresponding guarantee.

c. In view of the foregoing considerations, to safeguard the interests of the boiler manufacturers, for the dignity of the profession at large as well as an item of progress, subject to discussion and approval by this Association, the following recommendations are made:

1. That the determining factor of boiler performance be the rate of uniform supply of combustion gases by weight containing definite heat value per pound or per cubic foot corresponding to the best combustion conditions obtainable for all fuels.

2. That in stating boiler performance the ratio should be employed,

$$\frac{S \times (H - h)}{G \times (H_1 - h_1)}$$

where S = Lb. of steam produced;
G = Lb. of combustion gases supplied;
H = Heat content of steam produced in B.t.u. per lb.;
h = Heat content of boiler feed water in B.t.u. per lb.;
H_1 = Heat content of combustion gases in B.t.u. per lb.;
h_1 = Heat content of combustion gases at boiler temp. in B.t.u. per lb.

Briefly, pounds of steam produced per pound of combustion gases with specified content supplied should replace the boiler horsepower developed per pound of fuel burned.

3. Guarantees on boiler performance should be made on the basis of the foregoing ratio with tolerances allowed to cover the variations inherent to the nature of the fuels used.

TABLE I—COMPOSITION OF TYPICAL COMMERCIAL FUELS (AS RECEIVED OR AS FIRED), THEIR HEATING VALUE AND THEORETICAL (100 PER CENT) AIR REQUIREMENTS FOR THEIR COMBUSTION

Fuel No.	Kind of Fuel	Composition per Lb. Fuel in Per Cent C	H	O	S	Ash	Per Cent Moist.	B.t.u. per Lb. as Fired	100 per Cent Air Per Lb. Fuel as Fired Lb.	Cu.Ft. @ 60°F.
1	Low-grade lignite	39.4	6.8	43.8	0.7	9.3	36.2	6,600	5.0	65.5
2	High-grade lignite	57.8	6.0	31.0	0.4	4.8	20.7	9,940	7.5	98.0
3	Low-grade bituminous	60.9	5.8	19.2	3.7	10.4	12.7	10,990	8.4	110.0
4	Medium-grade bituminous	70.5	5.4	11.2	2.9	10.0	5.2	12,735	9.7	127.0
5	High-grade bituminous	75.7	5.4	10.3	1.2	7.4	3.5	13,700	10.3	135.0
6	Low-grade semi-bituminous	80.7	4.3	3.2	1.4	10.4	1.2	14,096	10.8	141.5
7	High-grade semi-bituminous	84.3	4.7	5.2	0.7	5.1	3.1	14,688	11.2	146.5
8	Ave. anthracite	75.2	2.8	4.1	0.8	17.1	2.1	12,472	9.6	125.5
9	Ave. fuel oil	86.7	11.8	0.5	1.0	0.0	1.0	18,570	14.1	184.5
10	Natural gas	$98.2CH_4+0.1C_6H_6+0.25CO+0.25O_2$						21,300	17.0	223.0
11	Ave. coke-oven gas	$6CO+42H_2+34.3CH_4+2C_2H_4+2C_6H_6+1.1O_2+2.6CO_2+10N$						14,384	11.35	149.0
12	Ave. Producers gas	$14.34CO+2.8H_2+5.56CH_4+0.1O_2+10.5CO_2+66.7N_2$						1,397	0.92	12.1

Quick Repair of an Eight-Inch Steam Main

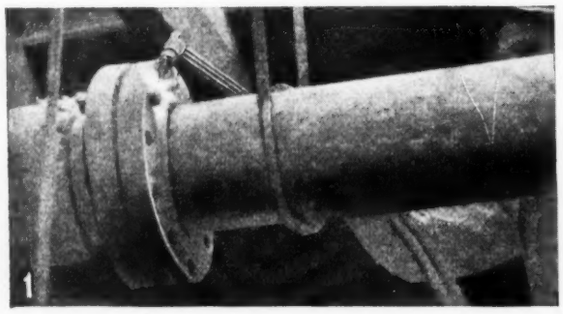
THE main 8-in. steam header from a battery of boilers was giving a brewery some trouble. The joint (Fig. 1) was made up of a Van Stone flange on the left and a screwed flange on the right. A leak at the thread of the latter could not be stopped. Having oxy-acetylene equipment, but appreciating that a job of this sort demands more than the usual experience, the company called for a service operator. He suggested installing a short length of pipe with a Van Stone flange to replace the screwed flange. Fig. 1 shows him cutting the bolt to remove the old flange.

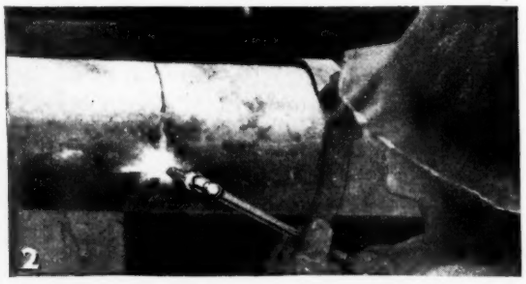
After the flange joint was thus relieved, the length of the new piece of pipe was laid off on the old. A measuring tape was stretched around the latter and a guide line chalked around its circumference. This insured a square-cut end. Fig. 2 shows the operator making the cut, inclining the head of the blowpipe toward the right to bevel the pipe at the same time.

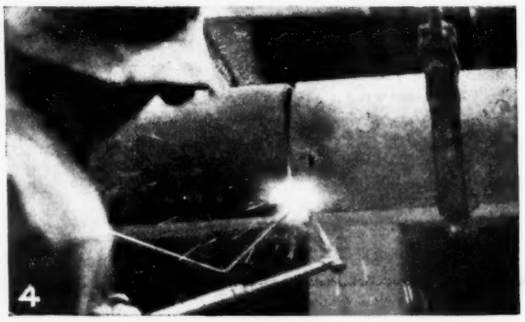
Fig. 3 shows the pipe after being cut. Note that the end is smooth and bevel. This clean cut was made while the operator was standing on a couple of planks extending from the top of the boilers to the coal bunker. The next step was to put the new piece of pipe in place. It was held by bolting its flange to the other already in line. After aligning the joint accurately by means of an adjustable pipe hanger, leaving a small space between pipe ends, welding was begun (Fig. 4).

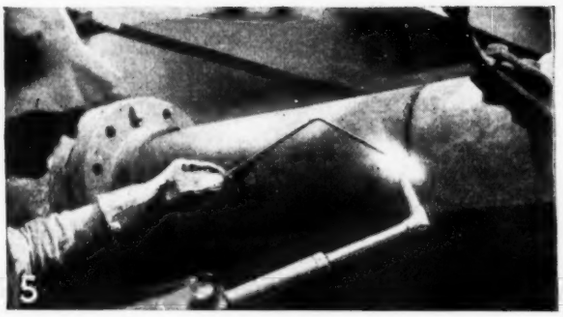
The oxygen and acetylene hose which led from tanks on the floor were carried up over the roof beams to take the weight off the blowpipe. This made it much easier for the operator, permitted freer manipulation of the blowpipe and hence made possible a better weld (Fig. 5). Note also that the operator began his weld at the bottom of the pipe and is working upward.

Fig. 6 shows the completed weld, which is built up slightly above the wall of the pipe to insure ample strength. It may also be seen that the pipes are in accurate alignment. The result of this job was a tight pipe line. It avoided the necessity of installing a whole length of new pipe. Taking out the old piece and installing a new one required only three hours.









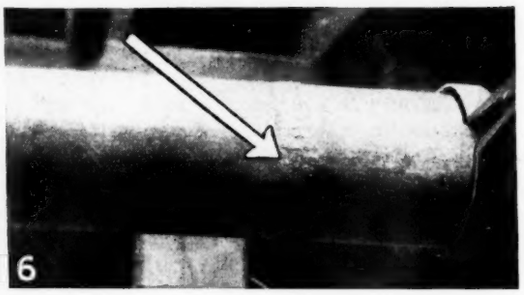


Fig. 1—The original joint, Van Stone on left, screwed on right. Fig. 2—Cutting off short section of pipe with screwed flange. Fig. 3—Pipe end after cutting. Note end is beveled. Fig. 4—Before welding, pipes are aligned by flange and pipe hanger. Fig. 5—Welder works from bottom up. Fig. 6—Finished weld rises slightly above surface of pipe

Relation Between Abrasiveness and Hardness of Carbon Brushes

By W. C. KALB
General Manager, Corliss Carbon Company, Bradford, Pa.

BEFORE attempting to explain the effects of hardness and abrasiveness as brush characteristics, it will probably be best to define what these qualities are. Hardness is the quality of being compact and solid, unyielding, not easily pierced. Abrasiveness is the ability to wear or rub away, to remove as by friction, to scour. From these definitions it is evident that the two properties so described are of entirely different character.

Considering the property of abrasiveness in its broad sense, apart from its special application to brushes, it is associated in our mind with small particles of extreme hardness, usually of a sharp, fragmentary form and bound together with more or less firmness into a body of the desired shape. For rapid cutting the bond is purposely made weak, so that particles whose edges have become dull may readily be carried away and new cutting edges presented to the work. As the strength of the bond is increased, the life of the abrasive block or wheel is lengthened, but at the sacrifice of cutting speed and with an increasing tendency toward glazing. This relationship of abrasive action to firmness of bonding is made apparent by reference to the literature of any manufacturer of abrasive wheels. There it will be seen that the soft wheels, that is, those of weak bond, are recommended for the rapid removal of large amounts of metal, while harder, or more firmly bonded, wheels are recommended when finishing to accurate size during the completion of an operation.

THERE is a great deal of confusion in the minds of brush users as to the relation between abrasiveness and hardness of carbon brushes. It is a common idea that a hard brush is more abrasive than a soft one. The author shows that of two grades of brushes containing the same amount of abrasive material, the soft grade will be more abrasive than the hard one. It is also shown that these two characteristics occupy two different fields in the quality of brushes with very little overlapping and it is essential that the purchaser of brushes understand this distinction in order to obtain a grade of brushes best suited to the application.

The abrasive property of the most abrasive brush is negligible in comparison with that of the common abrasive wheel or sharpening stone. Nevertheless, the fundamental principle affecting the rate of cutting remains the same. Of two brushes possessing the same percentage of abrasive material, the one with the firm bond will have less abrasive action than the other. In fact, a brush possessing an almost negligible amount of gritty material but poorly bonded, may have a noticeable abrasive action on the commutator or ring because of the rapidity with which the face wears away and new particles are brought into contact with the moving surface. This fact explains the abrasive characteristic of many natural graphite brushes, graphite being more difficult to bond into a firm structure than the amorphous forms of carbon, such as coke and lampblack. It also explains why a strong brush of firm structure, which is free from abrasive action under normal operation, may cause severe commutator wear when some condition is encountered that results in rapid disintegration at the brush face.

In view of the importance of this characteristic it is unfortunate that no standard exists by which abrasiveness may be defined, nor even a satisfactory test by means of which various grades of brushes may be rated in relative order of abrasive action. Analysis of a brush to determine the percentage of ash or non-carbonaceous material in its composition gives some indication. The character of the ash itself must be considered, however, as well as the firmness of the brush structure, so that accurate rating of dissimilar grades by this method is impossible. Comparison by running different grades side by side on a slip ring of uniform composition might seem to offer a satisfactory method of judging this characteristic. It has been found, however, that there is a tendency for certain grades to glaze more than others under such a test, while a different tendency may exist under the influence of commutation, which makes the results obtained on slip-ring tests an unreliable basis for comparison.

From observation of their various grades under service conditions most brush manufacturers are able to classify their brushes in order of relative abrasiveness for average conditions. This does not mean, however, that under some combination of operating conditions the relation between two grades may not be reversed. It does mean that the reputable manufacturer's advice on this subject is likely to be more reliable than any makeshift test other than a comparison on the specific application for which the brushes are desired.

In addition to abrasive action resulting from the composition or structure of the brush itself, abrasion may result from copper becoming embedded in the brush face. This free copper may come from the surface of a commutator or ring improperly cleaned after sanding or grinding. It may accumulate from a mild abrasive characteristic in the brush, or it may be deposited on the brush face by what appears to be an elec-

trolytic action, which sometimes occurs under severe commutating conditions. The tendency of free copper from any of these sources to collect on the brush face is greatly aggravated by the presence of artificial lubrication in the brush or the practice of applying oil, paraffin or a like lubricant to the commutator. These embedded particles of copper are destructive to a good commutator surface, usually being characterized by sharp ridges, sometimes of considerable height.

Cause of Commutator Wear

Severe sparking may in itself be a cause of rapid commutator wear, and it is not uncommon for a complaint of abrasiveness to be made when poor commutation is the source of the trouble. This cause of wear, however, is not accompanied by abrasion in the commonly accepted sense of that term unless the brush faces have picked up copper as discussed in the preceding paragraph. The wear is rather a result of the burning of the commutator surface by the intense heat of the sparking.

So far consideration has been given only to the characteristic of abrasiveness, in order that a clear understanding may be reached as to its relation to brush composition and service conditions. Attention may now be turned to the other characteristic, hardness, which is so often confused with abrasiveness.

Referring to the definition given in the first paragraph, it will be seen that hardness as applied to brushes refers to the ability of the brush surface to withstand pressure or resist indentation. This property is the basis of the standard by which relative hardness is defined, and it is with this property in view that all instruments for the measurement of hardness have been designed. The instrument best adapted for comparing hardness of carbon brushes is the scleroscope. This instrument compares the hardness of different specimens by measuring the rebound of a small diamond-pointed weight dropped from a fixed height upon the piece being tested. While unsuited for the comparison of unlike materials, such as rubber and metal, it offers an acceptable means for classifying materials of like character, and is used by practically all carbon manufacturers in defining the hardness of their various grades of brushes. It must be borne in mind that the units of this test are purely arbitrary and that it cannot be said that a brush giving a scleroscope rating of 60 is twice as hard as one reading 30 or four times as hard as one reading 15.

Confusion Exists with Regard to Brush Characteristics

It is unfortunate that confusion ever exists in the use of these terms hardness and abrasiveness. Both characteristics are of importance in the selection of suitable grades of brushes, but of the two abrasiveness is probably the more important. In spite of this fact, hardness is more often specified on brush orders than is abrasiveness, even though the characteristic the purchaser desires to define is abrasiveness rather than hardness.

Abrasiveness in a brush is primarily undesirable, provided the need for it can be eliminated. Not only is it a source of commutator wear, but it greatly increases the brush friction and heat losses of the machine. However, where a tendency toward high mica exists which is impracticable to remove by undercutting, or where atmospheric conditions tend to form a corrosive deposit on the commutator or ring surface, the use of a brush possessing sufficient abrasiveness to maintain a smooth, clean contact will probably result in a reduction of wear. Even with undercut commutators some operating conditions, particularly those accompanied by bad commutation, demand a certain amount of abrasive action from the brush to counteract the burning action of the sparking. If the mica is undercut and commutation reasonably good, brushes with little or no abrasive action are to be preferred.

Hardness Less Important Than Abrasiveness

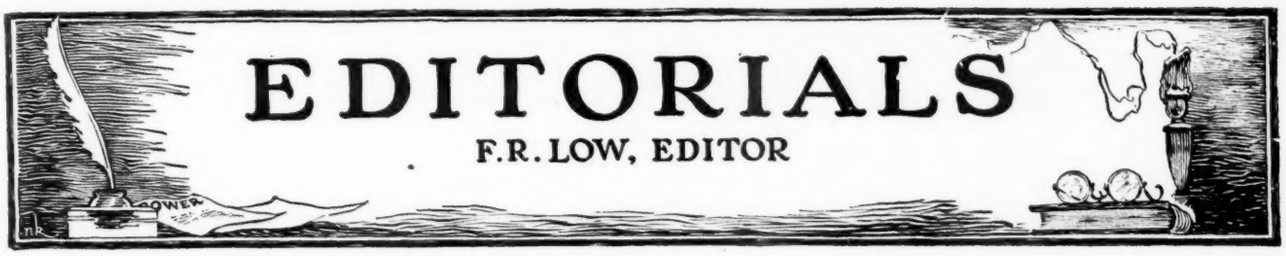
Hardness, as previously inferred, is of less importance in most cases than the abrasive property of the brush. Many instances may be cited where the same machine has given satisfactory performance with either a hard or soft brush whose other characteristics were properly adapted to the application. The fact that hardness is usually accompanied by improved mechanical strength, makes the harder grades preferable for applications in which the brushes are subjected to severe mechanical stress. Railway motors and crane motors may be cited as typical examples on which relatively hard brushes find general preference. The hard brush possesses the advantage of some cleaning action even though entirely free from abrasiveness. Soft brushes, on the other hand, are less susceptible to chattering than hard ones, since they do not rebound so readily under the impact of vibration. While purely mechanical wear of soft brushes is greater than that of hard brushes, electrical disintegration of the brush has usually a greater effect on brush life than mechanical abrasion, so that a soft brush commutating properly may outlast a hard one that has poor commutation.

From the foregoing analysis of the influence of abrasiveness and hardness on brush operation it may be seen that the effects of these two characteristics occupy different fields with little overlapping. It is, therefore, essential that the purchaser of brushes, when specifying the characteristics desired, should clearly understand this distinction in order to obtain a grade that will give the required performance.

To make motor installations safe electrically for the operators, there must be as few live parts exposed as possible; and to make them safe for the maintenance men while changing fuses and making repairs, they must be accessible, so that it will not be necessary to climb ladders or work in close, dangerous places.

If due care is exercised, the mistake of grounding a live conductor will not occur, nor will grounded cables be left connected to a circuit that is energized. An important precaution to be taken when applying any grounding device is to make good contact with the conductor at once, so that an arc or flash will not develop if the conductor should, by some mischance, be energized, and grounding clamps should always be applied at the end of a switch stick, if possible.

The distance around a cylinder increases $2 \times 3.1416 = 6.2832$ in., say $6\frac{1}{4}$ in., for every inch of thickness of a layer of material placed on it. This relation holds regardless of the original diameter. For instance, if the outside circumference of a given pipe is 44 in., a 2-in. thick layer of pipe covering will increase the circumference to $44 + (2 \times 6\frac{1}{4}) = 44 + 12\frac{1}{2} = 56\frac{1}{2}$ in.



An Uneconomic Practice

COMPLAINT is frequently made by manufacturers concerning the practice of some engineers of broadcasting specifications and inviting a large number of bids when the choice has already been limited to two or three. This unnecessary expense to which the manufacturer is put in preparing estimates, augmented sometimes by a salesman's time and railroad fare, tends to increase the cost of doing business and is reflected in the selling price. The purchaser, collectively speaking, is the one who pays in the final analysis. He would probably protest vigorously any attempt to impose a direct service charge for the preparation of bids, but when it is absorbed in the selling price he does not so readily discern the effect of his habit.

It is quite true that the purchaser is not always to blame, the aggressiveness of a sales force and the theory that a sale is never lost until the other fellow has signed on the dotted line, are other factors. Wherever the responsibility in the particular case, the fact remains that the practice is grossly uneconomic and a detriment to merchandising efficiency. The buyer needs some education as well as the seller.

Automatic Apparatus

MANY of the things that were wont to be done laboriously and manually are now done with more precision and with less drudgery and exertion by simple mechanism.

The valves of the Newcomen engine were worked by hand until Humphrey Potter, a bright boy assigned to that job, rigged up his "scoggan," made a moving part of the engine do the valve handling and doubled the attainable speed.

The centrifugal governor made possible better speed regulation than could be attained by hand control.

In many places and for many purposes, more perhaps than we appreciate, we depend upon automatic devices, mechanical and electrical, to perform operations that formerly required human vigilance and exertion.

In the matter of feed-water regulators there has been a decided change in the attitude of the power-plant engineer and the inspection authorities.

In the old days of the shell boiler with large water space and run at a moderate rate of evaporation, an attendant would have no trouble in keeping the water line between the high and low danger limits, even with intermittent feeding, and many managers felt that there was less danger that a man would forget than that an automatic regulator would fail to work.

With the comparatively small amount of water in modern boilers, the rate at which it is evaporated and the variability of the demand, a feed-water regulator is of more importance. It not only apportions the water supply to the demand for steam with more promptness and precision than is possible with hand feed, but it is continually on the job, and it can stay there and keep the boiler full when conditions become untenable for the human attendant.

Of course there must be human oversight, but the dependability of such apparatus has increased with the years, and the modern way is to have the operator exercise such intelligent supervision over the condition of his accessory appliances as he does over his safety valves and other automatic apparatus, that they may be relied upon to perform mechanically and automatically the functions formerly performed by unassisted human manipulation.

Insulation Makes the Plant Livable

WITH hot summer weather comes renewed appreciation of the fact that conservation of fuel is not the sole purpose of heat insulation. A bare steam pipe is a highly effective radiator—more efficient than the same amount of surface in the ordinary commercial radiator, because it stands more or less alone and does not have to work on the hot air rising from other coils.

A one-inch thick covering on a given steam pipe may save 70 per cent of all the heat that would be wasted if the pipe were bare. Doubling this thickness might increase the saving to a little less than 85 per cent. The difference seems small expressed in these percentages. But call the loss in the first case 100 per cent and that in the second case is seen to be a little over 50 per cent. By doubling the thickness of insulation the heat turned loose is practically cut in half, leaving out of consideration the effect of the boiler walls and other uninsulated heating surfaces this thicker insulation should practically cut in half the amount by which the room temperature exceeds the outdoor temperature.

What power-plant employee would not welcome an indoor temperature drop from 90 deg. to 80 when it is 70 outdoors? In these days such considerations of comfort have a direct bearing on the quality of workers available and the character of their work.

Refractories Boiled Down

THE refractory investigation instituted by C. F. Hirshfeld and now being carried out by the Bureau of Mines was the subject of the leading article and an editorial in last week's issue. The present issue gives the second part of the preliminary report, practically verbatim. Its value lies not in new facts revealed, for it does not pretend to report things formerly unknown. The particular value of Part II lies in its usefulness as a summary of the main facts regarding the chemical composition, physical properties, methods of manufacture and principal fields of application of the commercially important refractories. This information has been previously available to ceramic experts, but the average engineer in the power field has no time

to wade through ponderous books on the subject and should therefore welcome an outline prepared by experts to meet his particular needs.

While this report is in no sense abstruse and contains nothing that requires special education to understand, it may at first glance strike one as being dry reading, involving as it does the constant repetition of certain phrases differing only in the numerical values given. Yet it is only by this rather monotonous standardization of description that it is possible to get such an immense quantity of information into a single article. To one really interested in refractories in a practical way the byplay of thought set up by a study of the cold facts presented will supply the necessary illumination. Whether read in its entirety or only in those parts dealing with certain refractories of particular interest to the reader, the article is worth clipping and filing as a miniature encyclopedia of refractories which may come in handy at some future time.

Internal Inspection of Steam Turbines

THERE are two conflicting viewpoints, one to play safe and thoroughly inspect steam turbines at regular intervals, as opposed to the second of letting machines run until the need of overhauling is plainly evident. In deciding on the course to pursue, however, the apparently wiser procedure is not always the best, since there are many factors to be considered and what would appear as a justified caution with regard to one requirement may really represent an undesirable chance taken in some other direction.

Small turbines require comparatively little time for dismantling, and the regular weekly or monthly shutdown periods are usually sufficient. Besides, when installed in duplicate, dependability is less of a necessity. Internal inspection could be of little value except to establish the nozzle and blading condition. This may be indicated by ability to pull the regular fixed load of which inlet steam pressure is a first-class index. Also there may be little tendency to erosion as shown by the action of steam in other prime movers. Regular internal inspections under such conditions need hardly be of frequent intervals if at all.

Conditions, however, are much different for medium-sized or large prime movers. Repair work may require relatively much longer intervals. Perhaps reblading could be done without serious loss only during some special season of light load. Accurate knowledge of deterioration and its probable rate is highly desirable, so that repairs can be scheduled in advance. Besides external evidences of some troubles may appear as sudden and serious in character, requiring immediate shutdown.

One should not infer, however, that complete dismantling and inspecting of a large turbine is necessarily a wholly advantageous proceeding. Medium and large capacity machines are of relatively delicate construction. Heavy casings must be lifted up and lowered down in close proximity to blades that are much less rugged. Skill is required and some risk involved. The making of tight casing and bearing joints is not always easy. Foreign substances must be excluded, and many things point to the fact that an operation of this kind should not be taken lightly.

In practice, internal inspections are ordinarily scheduled at from six months to two years or greater intervals. By carefully recording and comparing stage pressures under equal conditions of load, steam and exhaust at regular intervals, much of the necessity for frequent inspection can be reduced. Factors rendering inspections desirable must be balanced against those of a deterrent character in order that the best interest of the station may be served.

Does Extra Heating Surface Pay?

HORIZONTAL tubular boilers make up a considerable percentage of boilers installed in industrial plants. Years ago each manufacturer had his own pet boiler dimensions and it was possible to purchase a boiler of practically any diameter or length. Reduction in the sheet sizes and the tube lengths produced at the steel mills has served to eliminate all but a few boiler sizes and manufacturers have adopted almost universally the same dimensions for a given boiler capacity; for example all list a seventy-two-inch by eighteen-foot boiler as a standard size. As a result there no longer exists the old competition to induce the prospective customer to insist on some size through which one bidder would have the advantage. Undoubtedly standardization of boiler sizes has reduced costs.

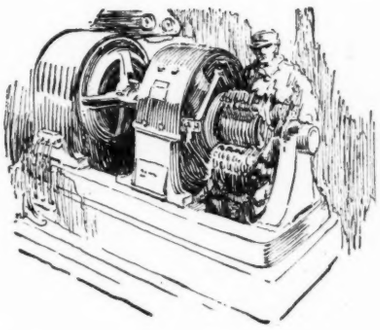
In one particular, however, the process has not been carried to completion. There is still a lot of argument as to proper number and size of tubes. In a seventy-two-inch by eighteen-foot boiler, one manufacturer offers, say, one hundred and ten tubes three inches in diameter, pointing out that they give a greater heating surface than the eighty-four tubes of four inch diameter specified by a second builder. Surely both designs cannot be right. Either one is too liberal or the second is stingy with the heating surface, which prompts the bewildered plant engineer to ask if any one knows the proper size and number of tubes to give best results.

The question is a proper one and so far as known no answer based on tests is available. One might naturally infer that the greater the heating surface the larger would be a boiler's capacity. On the other hand, there is some evidence that the greater part of the furnace gases pass through the top rows of tubes. Is it possible that under certain conditions practically no gases enter the lower tubes?

If a large number of tubes is desirable then slight additional cost is justified. The subject of heat transfer in fire-tube boilers is worthy of study. Combined with a study of water circulation it offers a wide field for research.

Some engineers are always reading and studying, grabbing at facts and opinions as a miser grabs at gold. Yet they somehow never seem to develop a critical faculty that enables them to distinguish between truth and error or a creative capacity fitting them to draw proper deductions from a set of facts presented in writing or encountered in their daily work. What is wrong in such cases? The difficulty often lies in a wrong conception of the nature of education. Soaking up unassimilated data and conclusions is one thing; education is another. The real student eternally asks *why* as he studies. Why is this? Why is that? Does this accord with the other things I have learned? Is it really so? Cannot I knock the pins out from under this argument and prove the direct opposite? Only by such questionings applied to the daily menu of supposed truth can one become truly educated.

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for July will be announced next month.

Two Accidents from the Same Cause

Two accidents have happened recently to steam engines in the vicinity of my plant, on account of failure to dispose of water in the cylinders. Both of these are simple non-condensing engines, neither is complicated, and the operation of both requires only ordinary engineering ability. Nevertheless, both wrecks caused serious delay to the plants and necessitated expensive repairs.

In one case an engine that had been run every day for a long time was started up in the morning without taking the precaution to drain the cylinder properly, with the result that the piston rod was badly bent. Owing to the location of the bend it was difficult to remove the rod. As there was no stock available the right size to make a new rod, it was necessary to take a much larger piece and turn it down.

In another case, an engine that had been shut down for several weeks was wanted for regular use. When it was laid up, the stop valve at the boiler and the throttle valve at the engine were left wide open. When the engineer was about to start the plant, he filled the boiler to a proper height with water, closed the stop valve and built a fire in the furnace. Having secured the necessary steam pressure, he opened the stop valve, but did not close the throttle valve.

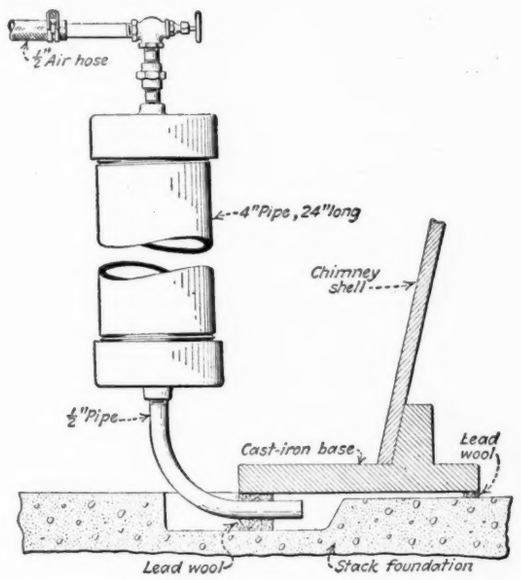
As the piping was cold, the first rush of steam was condensed, but the pressure was sufficient to start the engine. As there was no drip pipe to relieve the cylinder water collected and stopped the piston, but the momentum on the flywheel was sufficient to cause the piston rod to be pulled out of the piston. The rod had been pressed into the piston and riveted over when the engine was built, which was sufficient for ordinary service, but not for this unexpected abuse.

New Haven, Conn. W. H. WAKEMAN.

Special Grouting Prevents Stack-Base Movements

We had been anxious for some time about the movement on its base of our 7x200-ft. self-supporting steel stack, as in spite of pulling down as hard as we dared on the nuts of the foundation bolts, the outer edge of the baseplate would rise $\frac{1}{16}$ in. or more in gusty weather. It seemed likely that the base had worn the concrete under it into a sort of cup in which it worked and that this was likely to continue until the motion became great enough to cause wreckage of the stack.

After a considerable discussion the most practical way of tightening this up seemed to be by the use of a grout gun, which was made as shown in the figure. The baseplate was calked around at the edges with lead wool, and midway between each pair of foundation bolts a recess was cut to take the $\frac{1}{2}$-in. pipe of the grout gun. Then one calm Sunday when there was no noticeable motion of the base a neat cement grout was mixed about the consistency of thick cream, and after calking around the outlet pipe with lead wool as shown, the grout was forced in with air at 90 lb.



Compressed air forces grouting under base plate

pressure. Neat cement was applied, as it was uncertain how large the space under the base was and the particles in the grout must be fine enough to be sure to pass.

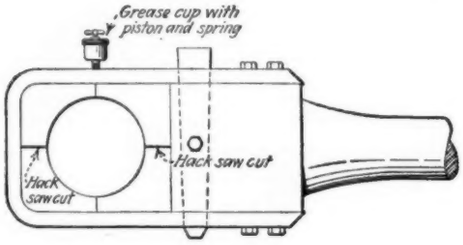
Each hole took somewhat less than a pint, which was apparently well distributed, as the results have been satisfactory. Observations during several gusty thunderstorms have shown no motion directly perceptible to the eye or feeling, though by using a multiplying lever it can be seen that there is still a slight motion of a few thousandths of an inch. H. D. FISHER.

New Haven, Conn.

Hot Crankpin Brass Remedied by Sawing Into Four Pieces

The sketch shows a remedy for a hot crankpin brass that was causing continual trouble and delay to a sawmill engine 75 hp., 200 r.p.m., carrying a heavy load.

Upon being asked to have a look over this job, an examination disclosed that the brasses were correctly fitted but light in stock. Therefore it appeared that



Brass sawed into quarter sections made cool crankpin bearing

when load was on, the brasses yielded at points, thus gripping the 3.5-in. diameter pin, and as soon as the load came off they would spring back into correct position and make the trouble misleading. Therefore I decided to cut them through the backs with a hacksaw at points shown in the figure, making four pieces in order to stop the springing and give accommodation.

Grease cups were installed that contained pistons and springs. The result has been a good running job ever since. P. K. WALSH.

Port on Port, Newfoundland.

A Study in Engine Jacks

The accompanying photograph, Fig. 1, of two gas engine barring-over jacks shows the difference of views of the engine manufacturer and the operating engineer

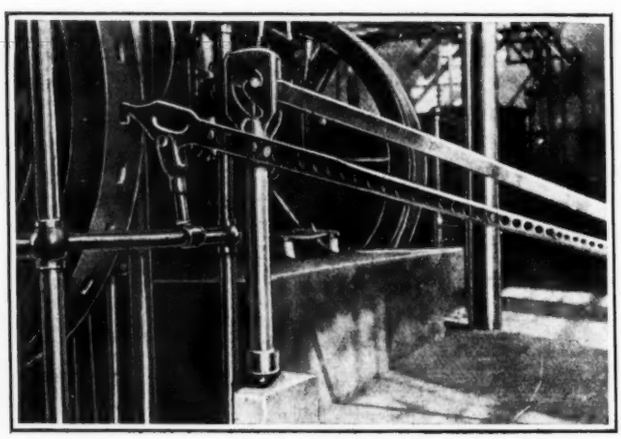


Fig. 1—Preferred lighter jack shown at left

as to what is necessary to bar an engine into starting position or for checking valves.

The one shown at the upper and back of the photograph is the typical jack furnished by a large engine company. It weights 96 lb. and requires two men to handle it. The structural one in front made by the writer weighs 28 lb. and can be easily handled with one hand yet is still strong enough to withstand the efforts of two men when necessary with an extension piece of pipe for greater leverage.

This particular jack was made with a short leg with a 2x½-in. malleable pipe tee cut in half to fit on the guard railing. To use as a floor jack, it is only neces-

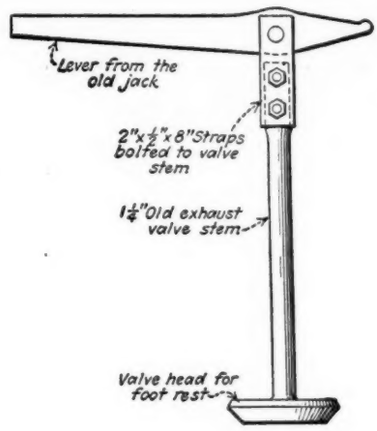


Fig. 2—Engine jack made from exhaust valve

sary to make a 1¼-in. pipe leg the required length with a pipe cap or floor flange for a foot.

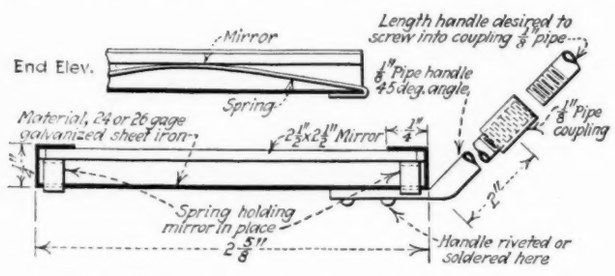
In another plant that I operated for a number of years, we used a jack made in a similar way except that an old all-steel exhaust valve composed the leg with two side straps bolted on it, as in Fig. 2. The head of the valve made a good substantial foot.

Sewickley, Pa. L. W. JOHNSON.

Practical Mirror for Inspecting Machinery

Another kink for the Practical Idea columns is a mirror for exploring and inspecting hard-to-get-at places around machinery, which we have devised and have found a valuable addition to our kit of tools. We find frequent use for this in the lighting plant; it is simple and easy to make.

Old broken mirrors can be picked up and cut to suitable size and kept in a convenient place for use. When



Holding device for machinery inspecting mirror

one gets broken a new one is easily slipped in place. The body is made of 24 or 26 gage galvanized sheet iron. A short piece of ⅜-in. brass tubing (we used brass tubing because we had it on hand) was soldered or riveted to the mirror frame with a coupling to screw on desired length of tube for the work used on. Other details appear in the figure.

Fessenden, N. D. D. W. LEWIS.

Comments from Readers

Increasing Financial Efficiency by Simplification of Plant Design

I was interested in the article in the May 19 issue on "Increasing Financial Efficiency by Simplification of Plant Design," as it touches a subject on which I have been working for many years.

The tendency in boilers has been to make every additional fuel-saving device not a part of the boiler proper, but something to be added to it. This can readily be seen by the fact that economizers or preheaters have, with few exceptions, not been made a part of the boiler setting, but have been added thereto in separate settings of their own.

The superheater has been placed in the boiler setting and connected to the boiler by means of outside pipes which take up a great deal of room. Owing to the fact that the superheater was in many instances added by a manufacturer of superheaters and not by the boiler manufacturer, the result was a rather cumbersome and expensive addition to the boiler setting.

The development of the air heater is now going through the usual phase of adding something to the boiler by means of another setting. All these additions to the boiler itself produce a rather expensive boiler house, as is clearly shown in the article referred to.

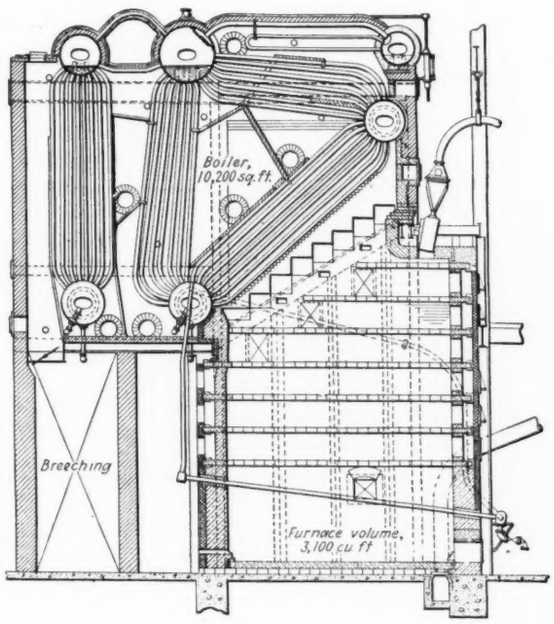


Fig. 1—Section of 10,200-sq.ft. boiler having heating surfaces in two stages and integral superheater

Generally, the boiler would be purchased from one manufacturer, the superheater from another, the economizer from a third, the induced-draft fan from a fourth, and it was then the purpose of the plant designer to co-ordinate these to the best of his ability.

The financial question, as well as the prejudices of the operating and consulting engineer, largely entered into the purchase and location of such additions to the boiler, with the result that often compromises were offered and accepted.

I have known of cases where the purchase of boilers was a matter thought over for weeks and then placed

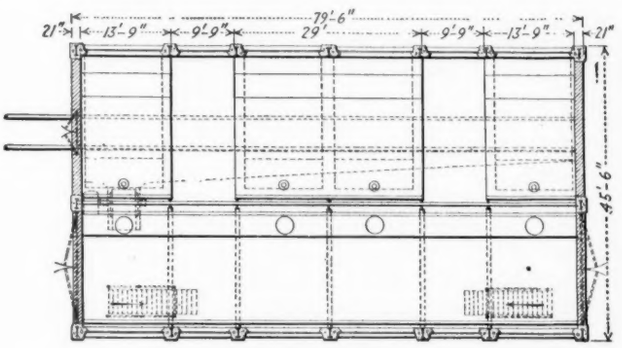


Fig.. 2—Plan of four 6,000-sq.ft. boilers showing size of building required

with the lowest tender irrespective of merit, and then an additional sum equal to 20 per cent of the cost of the boilers was spent on the building to put around the boilers, irrespective of the fact that the building itself did not produce any revenue to the boiler purchaser.

That work has been done on a design similar to that mentioned in the article is shown by Fig. 1, in which a 10,200-sq.ft. boiler with powdered-fuel firing and with integral superheater is illustrated. On test this boiler at rating showed an efficiency of over 92 per cent. The illustration shows the down draft to the breeching which is placed underneath the boilers and which leads to the induced-draft fan serving two boilers. This design does away with the separate economizer inasmuch as the heating surface in the boiler itself is divided into two stages. The superheater is also an integral part of the boiler without any outside connecting pipes.

Regarding the elimination of the radiation losses this has been accomplished in this particular setting by the design of the furnace in which the air is taken in at the rear and passes around through the side of the furnace and then enters the furnace in the front, with the result that the radiation loss in the test made on this boiler did not exceed 2.3 per cent. This furnace was designed and erected by the manufacturer of the pulverized-fuel equipment.

In Fig. 2 is shown a plan of four 6,000-sq.ft. boilers, and all in a space 57 ft. high, 45 ft. 6 in. wide and 79 ft. 6 in. long. The space between the boilers is shown to be 9 ft. 9 in., which is considered by most operators to be satisfactory for boilers having only a 12-ft. furnace width.

Fig. 3 shows a layout of four 8,500-sq.ft. boilers of a design similar to that shown in Fig. 1, equipped with underfeed stokers and induced-draft system. The total height of the building is 56 ft. and the lantern is 7 ft. 6 in. more. Large alleys are provided, there is abundant light, and the whole plant is very compact. The

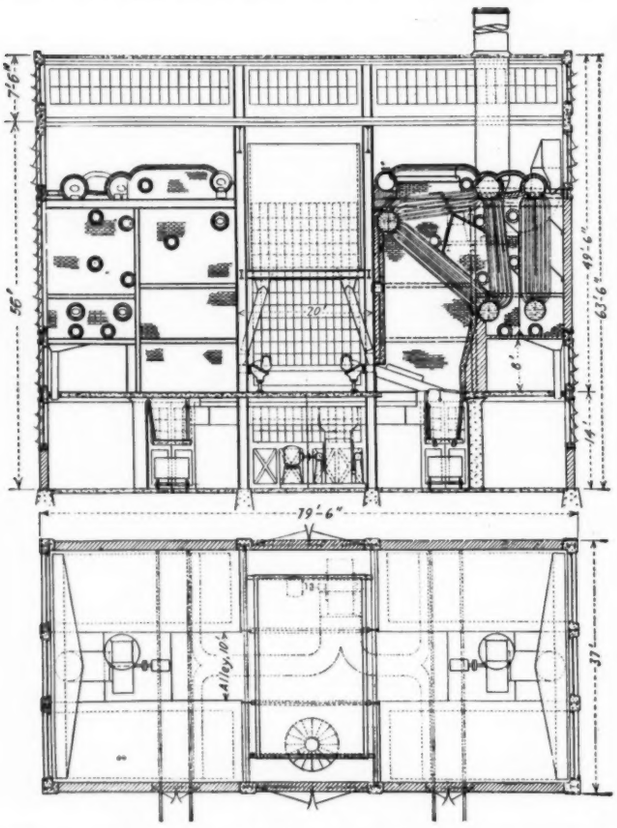


Fig. 3—Plan and elevation showing arrangement of four 8,500-sq.ft. boilers with forced- and induced-draft equipment

building is 37 ft. wide by 79 ft. 6 in. long, and the distance between the fronts of the boilers is 20 feet.

In conclusion, I might add that there is a tendency away from the haphazard co-ordination of boilers and their attendant fuel-saving devices such as superheaters, preheaters or economizers, air heater and breeching, and installations now in operation in which this desirable compactness has been secured prove that steps have already been taken in this direction.

PHILLIPS BADENHAUSEN,
Philadelphia, Pa. Badenhausen Corporation.

Measuring Coal on Traveling-Grate Stokers

The opinion advanced by Mr. Hogg in the July 14 issue, page 65, that records do not have to be absolutely exact to be of value I agree with. To be sure, the nearer exact a record is the more valuable it is, but most power-plant records are made with instruments, and there must be some error in any power-plant instrument so far devised.

The earlier flow meters, CO_2 recorders, watt-hour meters, etc., were far less accurate than the latest types developed, but they must have served some useful purpose, otherwise there would have been no incentive to have improved them. A manufacturer does not wait for the ultimate in a machine or process; he buys the best there is. Then when a better machine appears, rendering his device obsolete, he buys the new, knowing well that it will only be a question of time before this equipment in its turn will be a back number.

It appears to me that the volumetric coal meter for measuring coal consumption on traveling-grate stokers is about the most sensible development so far. It measures a *volume* of coal, thus eliminating the error due to varying moisture content. *Power* has demonstrated a number of times that the weight of a given substance contained in a given volume does not depend on whether the spheres are large or small.

Mr. Ogur, in his criticism of the method to which Mr. Hogg refers, admits that about the only error is in gate height. He says that the thickness of fuel bed may vary as much as 15 to 20 per cent for a given gate position. I question this as being anything like a usual condition.

Consider the case of an industrial plant burning a small size of anthracite. Coal has to be stored for winter use at a point some distance from the boiler house. It is trucked from the storage pile to the boiler plant, where it is conveyed to a bunker holding about 800 tons, and is burned on chain-grate stokers. This plant has no dependable record of the coal consumption except *by the year*.

Records of the weight of coal hauled are carefully kept, and at the beginning of each month the amount on hand in the bunker is estimated. This estimate may be 100 tons off, because the pile in the bunker is never level. The month's consumption can be estimated, but it is subject to this 100-ton error and is useless for purposes of comparison. This error becomes negligible at the end of a year, but a year is a long time to wait for records having a comparison value. The doctor might as well wait until the patient dies before making a diagnosis of the case.

The volumetric coal meter, one on each stoker, at least gives the chief a chance to find out whether one boiler is doing its job better than another or whether this fireman can coax more pounds of steam out of a pound of coal from a third, or whether the plant is getting along on less coal this week than last. And certainly such results have a tangible value to the company that strives to show a constant improvement, and wants a signpost to point the way. W. J. RISLEY, JR.

North Glenside, Pa.

Some Points Regarding Heat, Power and Byproduct Power

In connection with the use of process steam it must always be borne in mind that where sufficient use can be made of this byproduct for power, there is no cheaper power available. It is folly to generate power on an average thermal basis of 20 per cent and throw the remaining heat away when this can be utilized. That is what many plants are doing today. The factors entering into this cheap form of power are, first, the heat remaining for manufacturing after the power is utilized, and second, the small overhead involved in such an installation. In a power installation of any nature the ultimate object is, in general, the lowest price per delivered kilowatt-hour after all charges are taken into consideration. This should be the real engineering attainment. Any improvements made should be with

an idea to reduce the ultimate cost of the manufactured product whether for power or for material production. In some cases plants are revamped, requiring all modern equipment which will give a higher efficiency, but it must never be lost sight of that this higher efficiency must pay for the difference on the interest in the investment. This sometimes is lost sight of and a loss is realized in the net saving.

A great many public-service utilities are delivering a kilowatt-hour on a low B.t.u. consumption. I should much prefer, however, to see figures showing the cost per delivered kilowatt-hour after all charges and electric transformations are made. There is a growing tendency toward making comparisons only, on the B.t.u. consumption per kilowatt-hour generated which to my mind is unfair. The real basis is, what a plant delivered kilowatt-hour cost is, after all charges are taken into consideration. If this is done, a fairer comparison can be made of all existing stations and no fair comparison can be made unless it is on a cost basis. Plants may be installed with all the latest refinements to produce a low B.t.u. kilowatt-hour, but the cost of the installation may be so excessive that the fixed charges will offset the savings made. Such a plant will of course show a low B.t.u. consumption per kilowatt-hour, but the cost per kilowatt-hour may be much higher than a plant with a higher number of B.t.u. per kilowatt-hour. There may be business reasons why the cost per kilowatt-hour should not be the basis of comparison, but in my opinion it should be the only true and fair basis. It is possible for an old industrial plant that utilizes its process steam for power to compete and produce a kilowatt-hour for a lower price than a central station.

Manufacturers have in the past shown only partial interest in power development, and in many cases they have purchased power and consumed coal to furnish steam for process work when the power and process steam could have been furnished from the same coal. This condition has probably been due to the fact that the power costs have been so small in comparison to the total manufacturing costs that not much thought was given to the matter. The power plant was considered only a means to the end. Today, because of closer competition and business conditions, all costs in connection with a manufactured process are taken into consideration and more attention is being given to this. It is surprising that so little has been done up to the present time in connection with industrial power utilizing its byproduct, when the vast opportunities available are considered. If investigations are to be made, they should be made from a true engineering viewpoint. The generation of power should be compared in its true light with all true cost facts. There can be no fair comparison unless this can be done. In some cases manufacturers have purchased power, when under their own conditions with slight changes they could produce it at a less cost themselves. This applies equally well to some conditions of heating and lighting buildings.

One of the principal engineering opportunities today is the proper utilization of heat for power and process steam and the combination of these in all cases where it is possible to do so. Following this is a further development in the use of heat in manufacturing processes. In days gone by manufacturers of equipment would furnish apparatus to accomplish a desired result without giving much thought as to the economical use of heat.

Developments can and should be made in this as they have been made with auxiliary equipment in connection with power plants. This equipment has increased in efficiency owing to the demands of the designers and operators of power plants, and it has produced a more efficient apparatus, which has been a benefit not only to the manufacturers of the equipment, but to the users as well. Manufacturers of industrial equipment can furnish apparatus more efficient in the use of heat if required to do so, and instead of furnishing a machine just to dry material, they could furnish a machine to dry material on a guaranteed steam consumption. If industrial executives demand certain requirements, they can be met by the equipment manufacturers and in time a mutual benefit would be realized. The steam condensed per square foot of can-heating surface in a textile mill will be about 1.25 lb. ,and per square foot of pipe-heating surface will be about 0.4 lb. This refers to the average drying conditions in a textile plant, and of course varies with the material, steam, housing, and air-circulation conditions. This can be reduced considerably with a little study. Proper air circulation combined with the elimination of moisture and proper insulation will insure wonderful improvements. The question of drying is one of heat, air circulation and time element. There must be sufficient heat to dry the material properly, air must be properly circulated and in sufficient quantity to utilize the heat efficiently, and the air must be kept as dry as possible. This is accomplished by taking out a sufficient amount of air to keep the moisture reduced and replacing this with fresh air. The material must have sufficient time in its passage to emerge in a satisfactory condition.

One other thought is the amount of steam now being used in the various processes. Little consideration has been given to this. Valves and piping have been installed, and the operator has used them without giving much thought as to the amount really needed to accomplish the desired result. Studies can be made of this, and in many cases work can be as satisfactorily produced with less steam. In some cases there is too much heat used, less steam can be used and a better material at the same time produced. Another important form of saving is in the use of heat exchangers which will convert the heat wasted in spent liquors to incoming liquor for manufacturing use. This will in many cases realize a considerable yearly saving with a small capital outlay.

Manufacturers would do well to give a little thought to this whole subject. It will produce a saving and in many cases a much better material. Certain processes might be eliminated or combined into one. If all these points are studied and taken advantage of, a large saving will be made. It calls for plants and engineering co-operation that will lead toward utilizing all the heat units delivered in the steam. The ideal arrangements would be to furnish steam from the boilers, pass it through a non-condensing prime mover, utilize all this exhaust for industrial work, collect all trapped water and utilize it in process work and then pass all spent liquor through heat exchangers to transfer heat to incoming liquor. If this can be done, then little heat will be wasted and there will be no question as to who can furnish the cheapest power or deliver a unit of material at the lowest steam consumption. Let's get some education started along these lines. When this is accomplished, the results will more than pay for the time and work put in.

W. G. DIMAN.

Manchester, N. H.

Questions and Answers

Conducted by

Franklin Van Winkle

Trouble with Hvid Engine

We have an Hvid-type oil engine which we are running 24 hours and have experienced considerable trouble with a deposit of carbon in the fuel cup. What may be the cause? *E. C. H.*

The trouble undoubtedly is due to insufficient compression to give satisfactory combustion resulting from a worn piston or leaky valves, or a leaky fuel valve. Evidence of a leaky fuel valve would be a spouting of the fuel at the time of explosion. Another cause may be too large a hole in the cup. It is suggested that if an extra cup is available the hole or holes may be made smaller by peaning.

Refrigeration Capacity for Cooling Air

How much refrigeration capacity is required to cool 1,000 cu.ft. of air per min. from 80 to 40 deg. F., and how many square feet of pipe surface are required for the cooling coils? *H. F.*

In 1,000 cu.ft. of air at 80 deg. F., handled per minute, the weight of dry air would be 1,000 ÷ 13.6 = 73.5 lb., and assuming the specific heat at constant pressure to be 0.24, cooling the air from 80 to 40 deg. F. would require the removal of 73.5 × 0.24 × (80 — 40) = 705.6 B.t.u.

In addition, each cu.ft. of air contains some water vapor. If the humidity is 100 per cent, each cubic foot would contain as much vapor as contained in a cubic foot of dry saturated steam at 80 deg. F. and at the pressure of 1.029 in. of mercury, at which temperature and pressure the density is 0.00157 lb. per cu.ft. Hence 1,000 cu.ft. of air saturated with water vapor would contain 1,000 × 0.00157 = 1.57 lb. of moisture.

If the air is cooled to 40 deg. F. without change of pressure, the volume would decrease in the ratio of the absolute temperatures or inversely as (460 + 80) to (460 + 40), making the volume when cooled = 1,000 × (460 + 40) ÷ (460 + 80) = approximately 926 cu.ft.

At 40 deg. F. a cubic foot of water vapor would weigh 0.00041 lb., hence the quantity of water vapor that could be held in suspension in 926 cu.ft. of air at 40 deg. F. would be 926 × 0.00041 = 0.38 lb. and of the original moisture, 1.57 — 0.38 = 1.21 lb. must be cooled and deposited as water at 40 deg. F.

The latent heat of the original vapor (at 80 deg. F. and pressure of 1.029 in. mercury) is 1.046.7 B.t.u. and for condensing the 1.21 lb. before reducing its temperature would require 1.21 × 1.046.7 = 1,266.5 B.t.u.; and to cool the condensate from 80 to 40 deg. F., would require 1.21 × (80 — 40) = 48.4 B.t.u.; or for the vapor condensed out there would have to be removal of 1,266.5 + 48.4 = 1,314.9 B.t.u.

Assuming the specific heat of superheated steam is 0.5, to cool the 0.38 lb. of vapor from 80 to 40 deg. F. would require 0.38 × (80 — 40) × 0.5 = 7.60 B.t.u., so that the total heat to be removed would be 705.6 B.t.u. from air + 1,314.9 B.t.u. from moisture condensed to water + 7.6 B.t.u. for cooling remaining moisture = 2,028 B.t.u.

As one ton refrigeration per 24 hours is the removal of heat at the rate of 200 B.t.u. per min., for cooling 1,000 cu.ft. of air per min. under the conditions would require 2,028 ÷ 200 = practically 10 tons of refrigerating capacity.

If the air is to be forced across the cooling coil at considerable velocity, the heat transmitted per sq.ft. of surface per degree temperature difference per hour will be between 5 and 20 B.t.u., depending on the velocity. Assuming that with 40 deg. exit temperature of the air and the ammonia temperature in the coil 30 deg. F. there would be an arithmetical difference of [(80 + 40) ÷ 2] — 30 = 30 deg. and allowing transfer of 10 B.t.u. per sq.ft. of coil surface per hour, the coil surface required would be (2,028 × 60) ÷ (30 × 10) = 405 sq.ft. and if 1¼-in. pipe is used the coil would have to contain 405 × 2.3 ft. of 1¼-in. pipe.

Running Engine Over or Under

When does an engine run over, or run under, and which is better for the operation of the engine? *L. M. B.*

An engine is said to run over, or throw over, when from the direction of rotation the connecting rod rises as the crosshead begins to move from the outer end of its stroke toward the crank; and is said to run or throw under when rotation of the crankshaft is in the opposite direction. When the engine runs over, both the push exerted on the connecting rod during an outward stroke and the pull during a return stroke result in downward pressure of the crosshead on the guides in addition to the pressure due to the weight of the crosshead and connected parts, insuring greater rigidity and better lubrication than when the pressure is on the upper guide. When running under, the push and pull tend to raise the crosshead with pressure against the upper guide. Part of the upward pressure is counteracted by the weight of the crosshead, but the weight causes upward and downward motion at the ends of the strokes, giving rise to greater or less slapping or pounding noises. However, there are many instances where the direction of rotation of the receiving pulley or sufficient length for the driving belt make it necessary for the engine to run under and satisfactory operation is obtained by keeping the guides in good alignment and crosshead slippers in good adjustment.

Lap of Steam Valves of Duplex Pump

Why are not the steam valves of a duplex pump provided with lap? G. L. R.

The steam valves are given only enough lap to cover the irregularities of the ports, so the steam may be admitted for the full stroke of the piston. Any additional lap would increase the probability of having the valves stop in positions where all ports would be covered and under those conditions the pump could not be started. By giving the valves little or no lap, the chance of having all ports covered at the same time is practically eliminated.

Reduction of Air Pressure for Air Lift

In raising water from a well with an air lift, why are better results obtained from reducing the air pressure about 5 lb. lower than the pressure required to start the air lift? E. N.

In operating the air lift, the air pressure at any time must be sufficient for overcoming the hydrostatic pressure at the depth of submergence of the air pipe. During pumping the flow to the well cannot sustain the same head of water above the air outlet and consequently less pressure is required for injection of air. Greater air pressure than necessary for overcoming the hydrostatic pressure is a hindrance to flow of water to the well. The reduction of head is commonly referred to as the "drop" of the well. A reduction of 5 lb. per square inch of air pressure required would correspond with a drop of 5 ft. $\div$ 0.434 = about 11 ft. 6 in.

Connections for Pumps Operating in Parallel

When two or more pumps take suction from the same supply line and discharge into the same service pipe, how should the connections be arranged for operating both pumps at the same time? R. C. L.

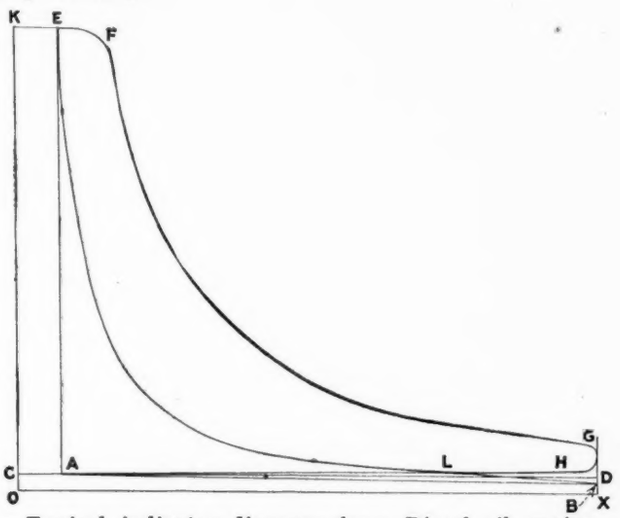
When suctions are taken from the same tank, reservoir or pond, they should be sufficiently separated to prevent one pump from disturbing the suction water of another by formation of currents or eddies. When suctions are taken out of a common supply pipe no larger than necessary for all pumps, the outlets of the supply should be by Y branches having areas in proportion to the respective displacements of the pumps supplied. For discharging into the same main the connections should be Y branches, or so arranged that the discharge from one pump will not be shut off by another due to connections being at right angles or conflicting directions of flow.

Comparison of Diesel and Steam Engine Indicator Diagrams

What are the distinctive features of an indicator diagram taken from a four-cycle Diesel oil engine as compared with a diagram from a steam engine? A. R. C.

The same terms are used for the different lines of the diagram, but instead of admission of steam in the beginning of the power stroke combustion of fuel takes place. Referring to the illustration, *CD* is the atmospheric line, drawn by the pencil of the indicator when the connections with the engine cylinder are closed and both sides of the indicator piston are open to the atmosphere, in the same manner as when indicating a steam engine; *AB* is the suction curve, showing the pressure against which the piston acts during admission of air to the cylinder and usually is nearly coincident with the atmospheric line; *BE* is the compression curve, showing the rise of pressure due to compression of the air taken into the cylinder during the suction stroke of the piston; *EF* is the combustion line, showing full pressure of gases during the injection and combustion of the fuel. With beginning of expansion at *F*, corresponding to cutoff in the steam engine, *FG* is the expansion curve showing the fall in pressure of the gases as they expand behind the moving piston of the engine; *G* is the point at which the exhaust valve opens, *GH* the beginning of the exhaust period and *HA* is the back pressure line during the exhaust stroke.

As on an indicator diagram from a steam engine, *OX* is the reference line of absolute zero pressure, drawn by hand below the atmospheric line at a distance representing 14.7 lb. by the scale of spring that was used in the indicator, and *OCK* is a reference line drawn at right angles to the atmospheric line at the distance *KE* to represent the percentage that clearance volume is of the whole volume of clearance and piston displacement.



Typical indicator diagram from Diesel oil engine

Since the pressures during the suction and discharge strokes are about atmospheric, the net average pressure usually is taken as though the work per cycle is represented by the simple diagram *EFGHLE*. The m.e.p. then is the area *EFGHLE* divided by the length of diagram, *AD* and multiplied by the scale of the indicator spring. Since in a four-stroke-cycle engine the power stroke occurs once in 2 revolutions, the indicated power developed is (m.e.p.) $\times$ length of stroke in feet $\times$ area of piston in sq.in. $\times$ (r.p.m. $\div$ 2) $\div$ 33,000.

Required Pipe Size for Given Steam Velocity

What should be the diameter of a steam pipe for a continuous flow of 6,000 lb. of steam per hour when the pressure is 90 lb. gage and assumed velocity 7,000 ft. per minute? C. H. D.

The specific volume of dry saturated steam at 90-lb. gage, or pressure of 105 lb. per sq.in. absolute, is 4.23 cu.ft. per pound, and the volume discharged per minute would be 6,000 $\div$ 60 $\times$ 4.23 = 423 cu.ft. To pass this quantity of steam at the velocity of 7,000 ft. per minute would require a pipe having a cross sectional area of 423 $\div$ 7,000 = 0.0604 sq.ft., or 8.7 sq.in., which corresponds to a diameter of 3.33 in. The nearest commercial size of pipe required would be 3½ in.

Utilizing Wood Waste as Fuel*

WOOD WASTE from the lumber-manufacturing industry is commonly referred to as "hog fuel." This term is incorrect as applied to all the refuse sold and correct only so far as it applies to that portion which has been manufactured by the process of feeding slabs, edgings, trimmings, etc., into a mechanical contrivance to reduce this wood to a uniform small size and termed a "hog."

There are four types of hog on the market. One differs but slightly from the chipper used to prepare wood in a paper mill for the digester in the production of sulphite pulp, and consists of a steel disk to which are attached knives.

A second type consists of two concentric cones bearing knives that revolve in a conical-shaped housing. A third hog is one in which a cylinder fitted with a row of knives revolves in a cylindrical housing. The fourth type is known as a "hammer hog," in which the wood is broken up by the impact of a series of hammers operating against the edges of anvils.

There are limitations as to the shape and character of the wood that can be fed to each of these types of hogs. The selection of the right hog for the duty imposed is important. All knife hogs are subject to dulling caused by tramp iron or other foreign material, and require frequent change of blades in order to maintain a uniform product.

Badly Hogged Fuel

As soon as the knives are dulled, there is a tendency for the wood to come through in shreds instead of chips, and these shreds may be of such length to to interfere materially with the handling of the fuel, and in particular with its discharge through independent openings in the conveyor system. It is sometimes necessary to "rehog" fuel, and in such an event two types may be used to advantage in series.

The expression "hog fuel" has by sufferance been extended to include not only the material that has been passed through a hog, but also shavings from planing mills, sawdust from saw kerfs, bits of bark, chips and other small recovered products from the manufacture of lumber.

Hog fuel as sold for commercial purposes therefore varies materially in its size, the amount of voids and the proportions of wet and dry wood it contains.

Tables in Original Paper

Tables showing the furnace volume per unit of wood waste, descriptions of the properties of various forms of such waste, and considerations that affect combustion are included by the authors.

In the Dutch-oven furnace fuel was fed through openings in the arch. In this type of furnace the conical pile or piles formed on the grate do not extend up furnace side walls, so it provides larger exposed areas of hot brickwork. Automatically, the length of gas travel was increased and a portion of the green fuel was shielded by brickwork from direct radiation of heat to the cool surface of the boiler. The extension furnace also permitted the use of a larger grate surface and in general allowed for greater latitude in proportioning it.

Drop Nosed Furnace Arch

The next progressive step in furnace design was the addition of a drop nose or curtain wall located at the inboard end of furnace arch. The purpose of this drop nose was to further shield the green fuel bed from boiler tubes, provide additional incandescent surface for reflecting heat on the fuel pile and the issuing gases, and to direct the gases downward into the combustion space beyond the bridge wall.

The furnace in Fig. 1 was designed for paper-mill waste. It follows closely the type for burning bagasse. Sloping step grates have certain advantages over the sloping smooth grate. Fuel is fed across the entire face of the furnace and drops down over the grate area in a blanket of more or less uniform thickness. The ordinary method of burning fuel in conical piles on flat horizontal grates means that the central portion of the fire is too thick and the outside edges too thin for the most economical results. It also makes necessary the supplying of most of the air required for combustion by the overdraft method, due to the greater portion of the fuel on the grates being burned on the surface of the cone.

Distillation Zone

In the step-grate furnace the upper portion of the fuel bed forms a distillation zone in which the volatiles and moisture content are rapidly driven off.

The lower portion of the fuel bed is a mass of incandescent carbon through which the air is readily drawn, due to its open or porous nature.

The process of combustion approximately consists of the uniting of air with the incandescent carbon to form the dioxide, which in turn, in passing through the remaining portion of the fuel bed, takes up carbon, to be reconverted into the monoxide.

Secondary air is admitted through tuyeres in the bridge wall and unites with the monoxide gas as it leaves the incandescent fuel bed to be reconverted to the dioxide. This secondary air also unites with the volatile gases driven from the upper portion of the fuel bed, and the furnace becomes in effect a combination of a gas producer and a gas-burning retort.

Gases Deflected Downward

The drop nose on the inboard end of furnace deflects these burning gases downward, allowing long gas travel before they reach the tube surface and insuring complete mixing and combustion of the gases through the passage.

With properly designed step grates there is no riddling of cinders or fuel into the ashpit. The slag that forms on the grate can be removed by slice bar between the grate openings with the plant in operation. The dump gates can then be utilized to clear the furnace of slag.

A hopper is constructed across the face of the furnace in which the fuel will form a seal preventing the admission of excess air. The secondary air supply can be separately regulated to correspond with the rate of combustion desired.

The hearth type of furnace, Fig. 2, was developed for high efficiency, showing favorable CO_2 and requires forced-draft fans and ducts, using no grates. Supplementary oil burners are added.

The Dutch-oven furnace, Fig. 3, is designed to give 1 sq.ft. of grate area to 2.7 sq.ft. of heating surface. A relatively large grate area is desirable on account of the bulky fuel containing 60 per cent moisture.

The 2-ft. drop in the flat arch nose deflects the gases downward, breaks up and ignites the gases coming in contact with it. A hollow bridge wall admits secondary air.

Flat Arch Under Mud Drum

Fig. 4 is required for wet hemlock chips. It contains a flat arch under the mud drum and oil burners in the rear wall. Wet hemlock chips, mixed with a little planer dust and shavings, is burned.

A vertical boiler, Fig. 5, is served in which the usual straight arch brought within 12 in. of the tubes is not used. This has shown good results.

A second arch is placed above the Dutch oven in order to provide combustion space in front of the tubes. Absence of grates is apparent; instead, air ducts are built in solid masonry with cast-iron air nozzles setting in cast-iron flange bases spanning the air ducts. These are covered with a brick floor into which the bases are built.

The nozzles fit into the bases with a taper fit, so that when one burns out another can readily be fitted in. The air is forced into these air ducts from a fan, so an air feed through the bed of fuel is insured, since with natural draft and open stokeholes this result is not often obtained.

Special Fuel Feeding Hole

The fuel feeding hole is so located in Fig. 6 that the thickness of the fuel bed is about 18 in. at the bridge wall, while at the front of the furnace it will taper to a feather edge. The experience of the Portland Electric Light Co. is that this principle tends to increase efficiency and capacity. On account of the lower moisture content, a greater volume of fuel than ordinary may be burned with equal draft.

Fig. 7 shows an ideal setting for a horizontal return-tubular boiler, 72 in. in diameter by 18 ft. long. The secondary air grate burns up such solids as blow over the bridge wall.

*Abstract of articles by H. W. Beecher, Claire C. Simeral, and C. L. Young read at the symposium presented at the Portland Regional meeting of the American Society of Mechanical Engineers, Portland, Ore., June 22-25, 1925. Arranged for and co-ordinated by H. S. Bastian, of Chas. C. Moore & Co., Portland, Ore., Mem. A.S.M.E.

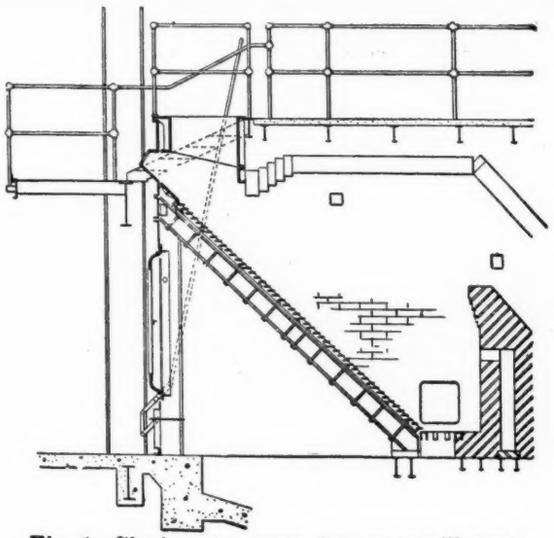


Fig. 1—Sloping step grate for paper-mill waste

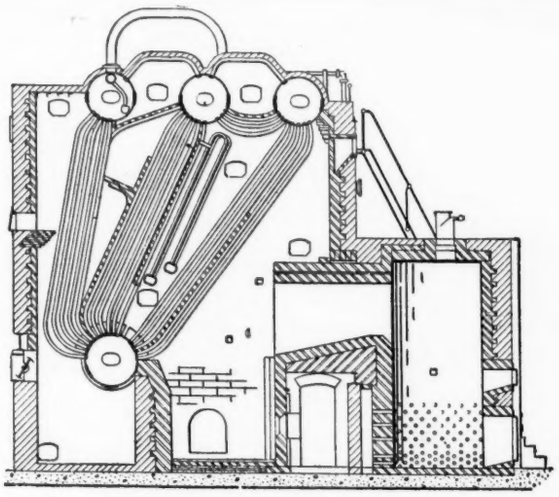


Fig. 2—No grates in hearth type with supplementary oil burner

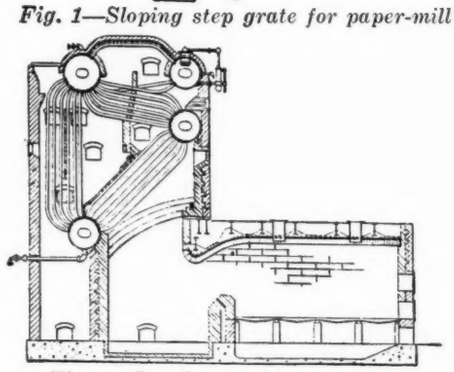


Fig. 3—Dutch oven for wet wood

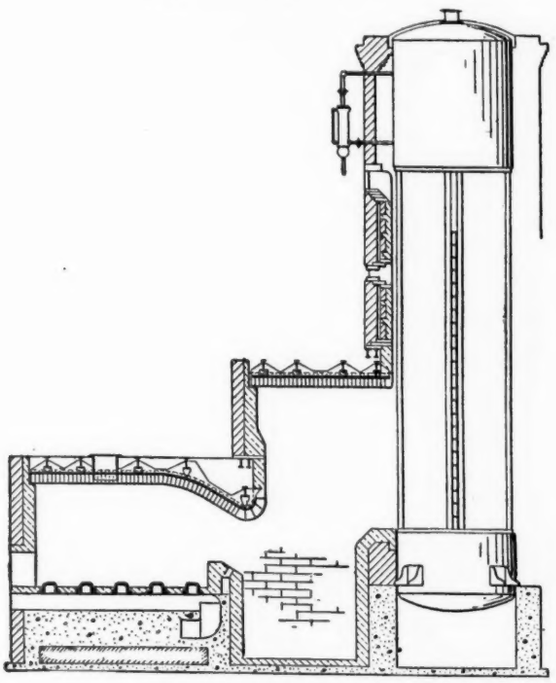


Fig. 5—Raised arch gives combustion space in front of tubes

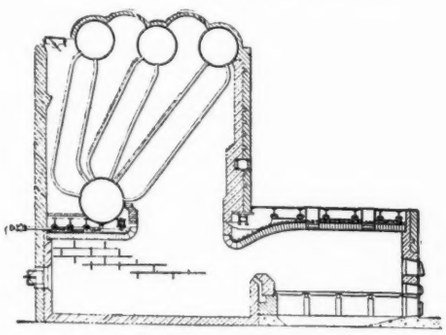


Fig. 4—Flat arch under mud drum for wet chips

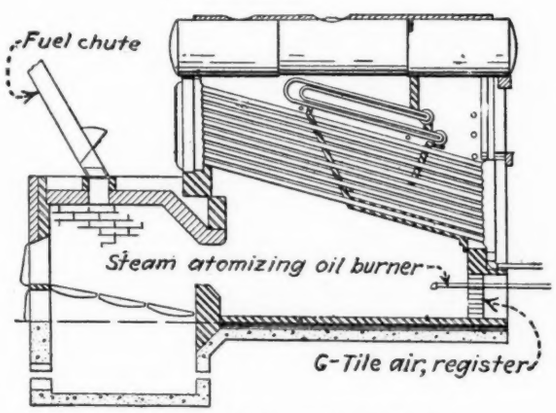


Fig. 6—Fuel hole specially located

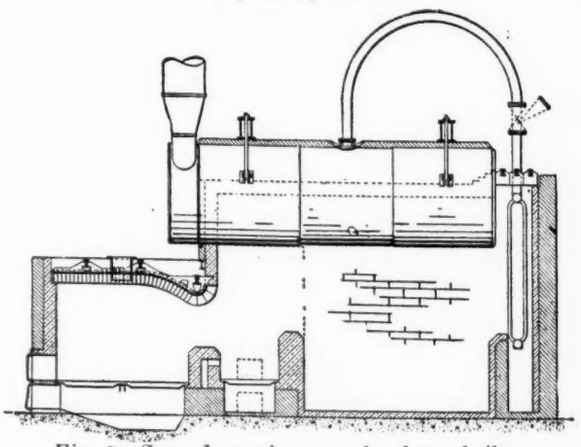


Fig. 7—Secondary air grate for h.r.t. boiler

New Italian Power Plant to Be Erected

The Societa Generale Electrica Tridentina plans to erect two new power plants, capable of generating about 230,000,000 kw-hr. per annum. They will cost about 100,000,000 lire.—Reported through *Commerce Reports* from C. Mathews, commercial attaché's office, Rome, July 4.

World Power Conference to Publish Journal

Discussion of the form of permanent organization, determination of conditions under which regional meetings could be held and trial publication of a journal were the principal three matters that came up for discussion at the meeting in London July 27 of the international executive committee of the World Power Conference.

Twenty countries were represented at the meeting. While no decision was essayed as to the time and place for holding the next world conference, the consensus of opinion apparently was favorable to a meeting in 1930. The invitation of Italy has priority. If conditions at that time are comparable to those now existing, it is probable the conference will go to Rome, but the executive committee would not allow itself to be committed thus far in advance.

European Section to Meet at Basle Next Year

While the committee was unable to accept the invitation of Switzerland to call another world conference at Basle next year, provision was made for sectional meetings. A meeting of the European section will be called at Basle and the international executive committee will meet there next year. This was satisfactory to the Swiss and will take care of similar situations when there is a demand for a conference in any one of the grand geographical divisions.

In submitting a form of permanent organization, the executive committee emphasized the desire to safeguard the conference in every way against becoming a super organization. The whole desire is to work out a plan whereby the central organization will be the creature of the national committees.

It was regarded as so necessary to the attainment of the objectives of the conference to have a publication that it was decided to publish "The Journal of the World Power Conference" for one year, to give it a trial. During this trial period, all expense of the effort will be borne by the British National Committee.

Sir Adam Beck of Ontario Hydro Commission Dies

Colonel Sir Adam Beck, K.D., internationally known as an authority on development and operation of hydro plants, and champion of publically owned power utilities, died on Aug. 16 at his home in London, Ont., from pernicious anemia. He had been ill for several months receiving treatment including several blood transfusions at Johns Hopkins Hospital at Baltimore during the early part of this year. He was thought to be much improved in May when he left

Sir Adam Beck built the Ontario hydro plant at Niagara Falls, and has

Sir Adam Beck

for years been identified with the policy of supplying the Canadian Province of Ontario with electric power. Appointed in 1903 a Commissioner to investigate the development and distribution of power from Niagara Falls, three years later he introduced a bill in the Ontario Legislature that created the Hydro-electric Power Commission, of which he has been Chairman ever since.

His last statement in public affairs was made in June, when he protested against the proposed lease of water power rights to Carillon Falls, on the Ottawa River, by the Federal Government to private interests, with the privilege of exporting 400,000 hp. or more electrical energy to the United States.

Born at Baden, Ontario, June 20, 1857, the son of Jacob Beck, he started in business in 1878 with his father at Baden, where the latter owned an iron foundry and milling property. He moved to Galt, Ontario, in 1880 and engaged in the veneering of thin lumber and the manufacture of boxes. Four years later he established himself in London, Ontario, built a large plant there and afterward became mayor of the town.

He was first elected to the Ontario Legislature in 1902, and was re-elected four times, the last occasion in 1923, in each case as a representative from London. He was gazetted a Colonel of the Canadian militia in 1912 and created a Knight Bachelor by King George in 1914. The crowning triumph of his career came when the Queenston-Chippawa power development scheme became a reality, and the public of Ontario became the possessor of the largest hydro-electric plant in the world. It has an ultimate capacity of 650,000 hp.

Sir Adam was one of Canada's greatest men of "incorruptible integrity"; known not only through his tremendous interest in power projects but through his many other activities and interests among which was thoroughbred horses. He was director of remounts in the World War and personally supervised the purchasing of army horses for the Canadian forces.

He is survived by a daughter, Mrs. Strathearn Hay of Toronto, a brother J. F. Beck, and a nephew, Horace Beck, of Toronto.

Hoover Backing Preservation of Niagara Falls

Mention by Secretary Hoover recently of the urgent need of a modest amount of engineering work to prevent the recession of Niagara Falls was distorted until some of the newspapers had him saying that "beautiful Niagara Falls is in danger of total destruction through diversion of water for electrical development."

What Mr. Hoover had in mind was the need for the placing of a submerged weir or the construction of diverting islands to keep the water from concentrating on the low point of the gorge. Mr. Hoover recognizes that the diversion of water for power purposes has added to the scenic value of the falls. In recent years since the erosion at the low point has become more pronounced, the disintegration would have been hastened had it not been for the reduction in the volume of water passing over the crest. The Canadians already have done some work looking to increased diffusion on their side.

The present position of the crest recently was photographed by the Army air service and the results now are being mapped by the Corps of Engineers. The map probably will be ready by Sept. 1 and will reveal the extent of recession as compared with maps made in previous years.

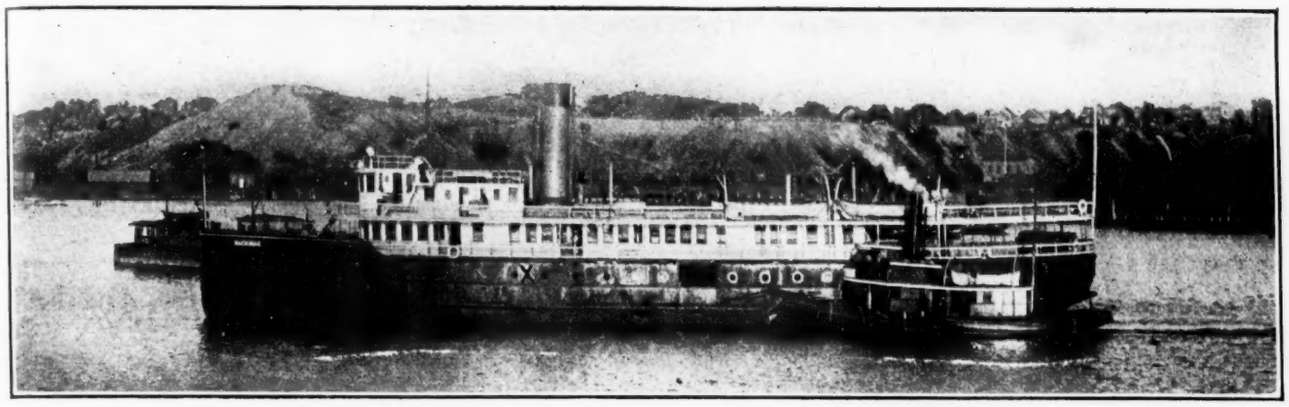


Fig. 1—The "Mackinac" being towed to Pawtucket after the explosion

Cause of the "Mackinac" Explosion

Forty-two Dead and One Hundred Injured on Steamer Mackinac at Newport, R. I.

ONE OF the two boilers on the excursion boat "Mackinac" ruptured on Wednesday, Aug. 19 just outside of Newport, resulting in the death of 42 and the injury of over 100 of the 670 excursionists on board.

The vessel is owned by the Blackstone Transportation Co. of Pawtucket, R. I., and for some time has been in service between Pawtucket, Providence and Newport as an excursion boat. Tuesday morning it started on a trip from Pawtucket to the beach at Newport, carrying about 670 passengers. While the boat was making a regular trip the majority on board were employees of the J. and P. Coates Co. of Pawtucket. This mill has been shut down and the force had decided upon the excursion, taking along members of their families. In addition one platoon of the police force went aboard, bent upon a similar picnic on the beach.

There was a delay in leaving the Pawtucket pier of about an hour. Statements made by several on board were to the effect that this was due to the necessity of welding one of the boiler fireboxes. Upon preparing to leave Newport at 5 p.m. a second delay of half an hour occurred by reason of boiler trouble. This was remedied and the vessel steamed out of the harbor to the strains of the music of the dance on the lower deck.

When about 4 miles from Newport and ¼ mile from Coddington Point the engine stopped and a dense mass of hot water, steam and soot shot out of the fire room, raising the lower deck floor about a foot and engulfing all those on the lower deck. The captain, who was in the pilot house, threw over the steering wheel and beached the boat at Coddington Point.

In the struggle to escape the clouds of steam, many jumped overboard and were rescued by sailors from the naval vessels anchored around Newport harbor. The sight that met the sailors and other rescuers when they gained the decks was beyond description. Men, women and children with the flesh literally dropping from the bones were rushing about, begging for relief from the frightful pain. Most of the injured were hurried to Newport hospitals and those able to travel were sent to Pawtucket on special trains.

The "Mackinac" was built on the Great Lakes in 1909 and was in service on these inland waters until purchased by the Blackstone Transportation Co. last year. For some time this company operated it between Pawtucket and New York City, doing a freight and passenger business but in May it was pulled off this route to take care of the excursion business.

The two boilers on the "Mackinac" are located almost amidship, at the point *X* in Fig. 1, and are of a type seldom found on coastwise or ocean-going vessels. They apparently are peculiar to the Great Lakes, although a somewhat similar design is used for heating boilers. In effect, as will be seen from Fig. 2, the boiler is a modified locomotive type, with the water legs continued to the front end. The crown sheet is semi-circular in shape and is

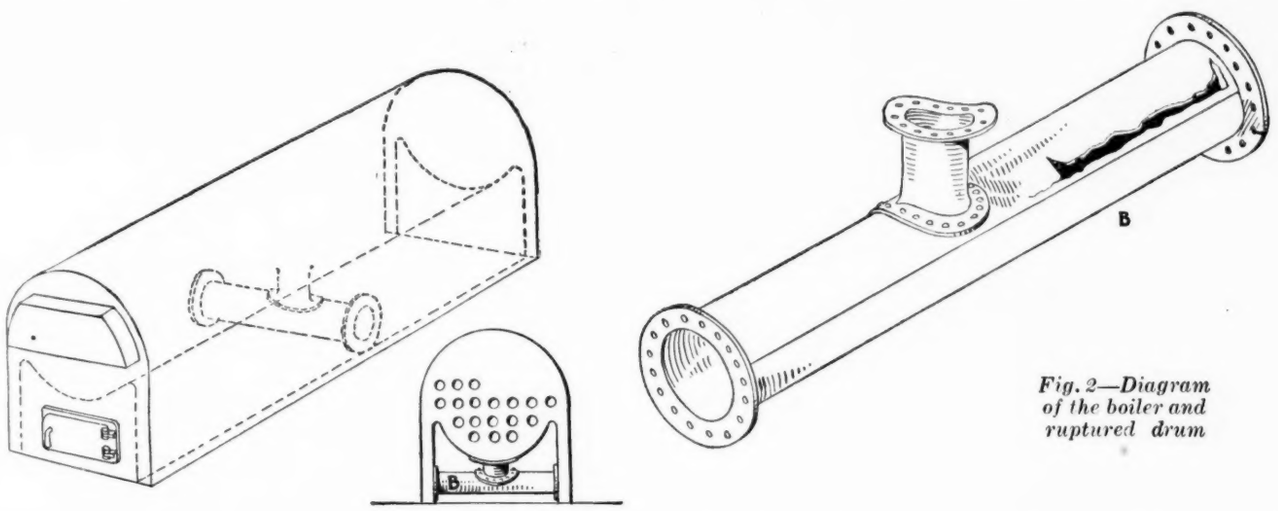


Fig. 2—Diagram of the boiler and ruptured drum

lap jointed to the furnace side sheets. The water legs are staybolted but the crown sheet, so far as could be seen, is not supported by either radial stays or crown bars. That this places an uncalculable stress on the curved portions where this sheet joins the sides is evident. However, the sheet did hold and was not the cause of the rupture.

The grate bars are set several inches above the mud ring at the furnace bottom and extend forward for about 6 ft. The gases pass along the under side of the crown, or bottom, sheet and after entering a smoke box at the further end, return through the nest of tubes. The smoke connection to the breeching is above the fire door as shown, and a single stack accommodates the two boilers which are set facing each other, with the firing aisle between.

Boiler Has Circulating Drum

A circulating drum is placed behind the grates and is connected at the ends to the furnace side walls. In addition a vertical nipple connects this drum to the bottom of the crown sheet. To protect the drum from the direct action of the fire a cast-iron baffle is placed against the rear of the drum, just in front of the grates; this is in effect a bridge wall.

As has been mentioned, there is much talk among the passengers that the boiler had been welded before leaving Pawtucket. Examination does not reveal any signs of the welding of any part of the boiler and it is possible that the welder repaired some pipe leak. The boiler is probably as old as the boat and it has seen severe service, for the furnace side sheets have been repaired a number of times, there being two soft patches and a number of renewed staybolts and rivets. These repairs, while of value as evidence of the service undergone, were not even contributary causes leading to the disaster.

Cause of the Explosion

Examination of the boiler shows that the explosion was caused by the rupture of the circulating-drum sheet. This sheet was originally about $\frac{7}{16}$ in. thick, the drum being around 12 in. in diameter, but due to corrosion the thickness along the lap was reduced to about $\frac{1}{8}$ in. The fracture extended from the right end of the drum *B* for a distance of some 2½ ft. At the right end flange, as viewed from the back end of the boiler, the tear continued upward along the drum for 6 inches and a similar cross tear occurred at the other end of the crack. As a result the sheet opened up, as shown at the right in Fig. 2, making an opening 2½ ft. long by 3 in. wide. Through this poured the hot water and steam.

The edges of the fracture are discolored or rusty. This condition extends along the entire break and indicates that the sheet has been cracked for some time. Just how long this has existed cannot be determined, although when examined on April 7, by the U. S. Steamboat Bureau at New York, no defect was discovered. Apparently the drum did leak for some hours before the explosion, for an engineer who was a passenger, states that there was a stream of hot water along the fire-room floor during the entire trip.

New Hydro Plants Planned for the South

Plans, it is announced, are under way for the eventual construction of a hydro-electric system which will develop the water power of the James River, of the Appomattox at Petersburg, and also at Roanoke Rapids, these sites to be connected by a 110,000-volt transmission line. The plans, when carried out, will make the Virginia Railway & Power Co. one of the largest in the South. This company, along with some smaller power companies in North Carolina, was recently acquired by Stone & Webster.

F. A. Gaby Temporary Ontario Hydro Commissioner

Premier G. H. Ferguson has announced that F. A. Gaby, chief engineer of the Hydro-Electric Commission of Ontario, has been given temporary powers of a commissinoer in order that business of the commission might not be delayed or hindered through Sir Adam Beck's death. The appointment will continue to be effective, the premier stated, until a permanent successor to Sir Adam has been selected. Two commissioners are necessary to carry on the work of the commission.

The death of the Hydro Chairman left Hon. J. R. Cooke, the sole member of the board the full-strength of which should be three.

Low-Temperature Distillation of Coal for Lakeside

An agreement has recently been signed by the North American Co., owner of the Milwaukee Electric Railway and Light Co. by which the International Combustion Engineering Co. of New York will install its equipment for low-temperature distillation of coal at the Lakeside plant of the company.

This will be the first installation of this low-temperature distillation system in America. It has been perfected after more than two years of experimentation at the Lakeside power plant by John Anderson, chief engineer of the Milwaukee company and the International Combustion company's engineers.

Initial Plant Will Treat 210 Tons Daily

The initial plant to be installed at Lakeside will provide for the treatment of at least 210 tons of coal a day, which is about one-fifth of the plant's present coal requirements. The coal is pulverized before being heat-treated, and the oils, gas and other residuals are recovered under low temperature. This leaves the coke in such form that it can readily be burned in a pulverized-fuel furnace. In fact, it can be burned with certain advantages over the burning of pulverized raw coal.

This idea could be tested commercially only in a large plant. The experiments show economy in using coal and also economy through the recovery of all manner of fuel oils and of gas, all of which can be separated from the coal and sold. This plant will provide valuable ways for conserving all the elements that are in raw coal.

Get Technically Trained Men for Public Technical Jobs

The American Engineering Council's administrative board, with headquarters at 36 Jackson Place, Washington, D. C., has recently passed a resolution advocating that public positions and offices requiring engineering or technical training, skill and experience be filled only with technically qualified persons. They state that it has come to the attention of the Council that these positions are often filled with persons wholly lacking the needed qualifications. They are urging all local engineering and technical societies to co-operate with the public to have all such positions filled with the men technically qualified.

San Antonio's New Plant to Be Finished This Year

Contracts for the installation of a complete generating unit for the new power plant of the Comal Power Co., a subsidiary of the San Antonio Public Service Co., at New Braunfeld, Texas, have been awarded to the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pennsylvania.

Included in the equipment is a 45,000-hp. steam turbine, a 37,500-sq.ft. condensor, and a 30,000-kw. generator of 13,000 volts.

The Comal power plant which will cost about $3,000,000 and which will include all the newest ideas in power plant design is expected to be completed within the year. It is designed to use powdered coal and will utilize the low grade coal or lignite mined in that vicinity at a considerable saving in the cost of operation.

A. I. E. E. Pacific Coast Technical Program

The revised schedule of technical sessions of the A.I.E.E. Pacific Coast Convention, which is to be held at Seattle, Wash., Sept. 15-19, contains various papers of interest to *Power* readers: Address of welcome by Dr. Henry Suzzallo, president of the University of Washington; president's address, Dr. M. I. Pupin; "Stored Mechanical Energy in Transmission Systems," by J. P. Jollyman, Pacific Gas & Electric Co.; "Steam Power in Its Relation to the Developments of Water Power," by R. C. Powell, Pacific Gas & Electric Co.; "Engineering Research —A Vital Factor in Engineering Education," by C. E. Magnusson, University of Washington; "Relation Between Engineering Education and Engineering Research," by R. W. Sorensen, California Institute of Technology; "A New Departure in Engineering Education," by Harold Pender, Moore School of Electrical Engineering, University of Pennsylvania; Symposium on Distribution Practice.

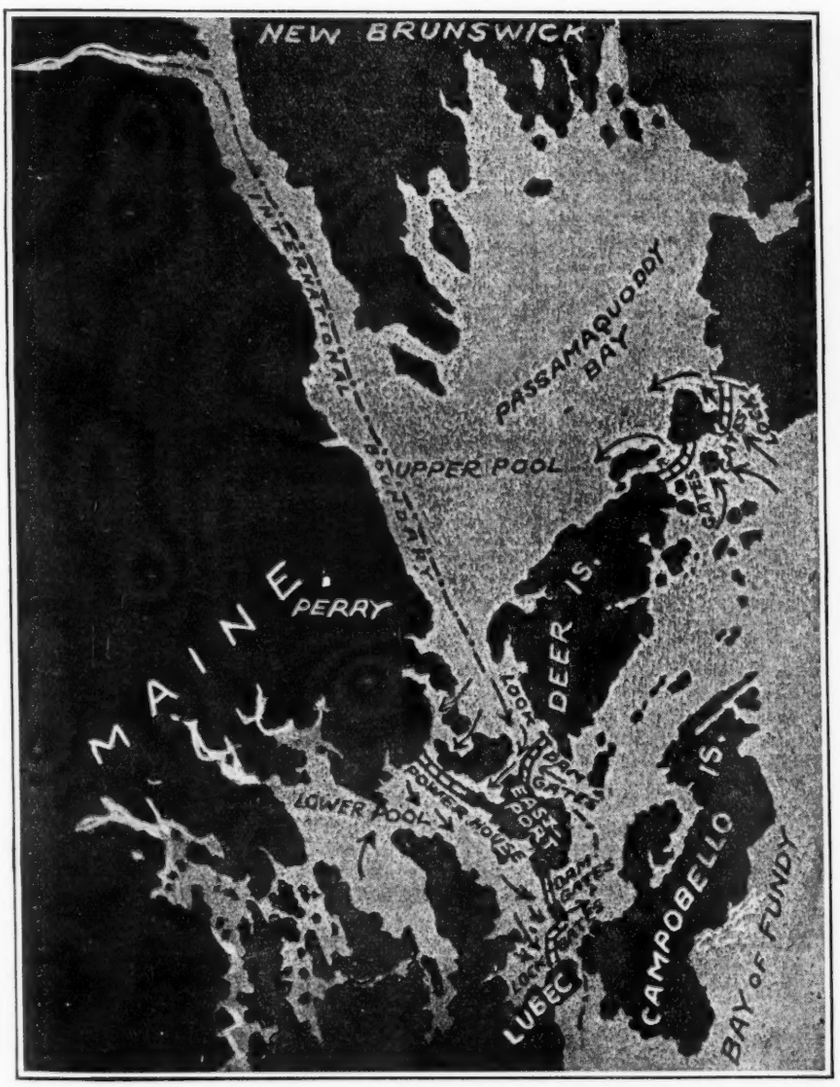
Fundy's Tides May Be Used for Power Generation

Dexter P. Cooper, Hydraulic Engineer, Plans a Development Costing Over $75,000,000 and Developing About 700,000 Horsepower

THE Passamaquoddy tidal power project, which is being planned to utilize the 27 ft. rise and fall of the tides in the Bay of Fundy, for generating between 500,000 and 700,000 hp., and which the hydraulic engineering firm of Dexter P. Cooper, Inc. proposes to develop, as outlined in *Power*, July 14, will go to a vote of the people of Maine at a special election to be held on September 14. The endorsement of the people is necessary as the laws of Maine forbid the export of power generated in the state. The block of power to be developed is so great that it would be impossible for the industries of the state to adequately utilize it, so special legislation is necessary for its export.

The project as planned by Mr. Cooper, who has been consulting engineer for the Guggenheim interests in South America, and who was associated with his brother Hugh L. Cooper in the building of the dam across the Mississippi River at Keokuk, Iowa, will be located in the bays bordering on Eastport and Lubec, Maine, and St. Andrews, New Brunswick, Canada.

Owing to the submarine topography and wedge shape of the adjacent shores in this region Mr. Cooper believes it is possible to construct works at reasonable cost. By regulating with a system of huge gates the inflow and outflow of the tides in two of the inlets of the Bay of Fundy and by large retaining walls creating two reservoirs or pools, between which the power house will be located, as shown in the accompanying drawing, Mr. Cooper expects to be able to develop between 500,000 and 700,000 horsepower.



Location of proposed Passamaquoddy Tidal Power Project—$100,000,000, it is estimated, will be needed for transmission lines and about $75,000,000 for the project

The theory of the scheme is: The gates of the upper pool are to be opened only during rising tides, while the gates of the lower pool are to be opened only during falling tides. This, according to Mr. Cooper, will keep a supply of water in the upper pool, while the lower pool will be repeatedly emptied. The fall of the water from the upper pool through the turbines into the lower pool, he asserts, will afford a continuous downfall whether the tides are rising or falling.

The advantage of his scheme over that of Muscle Shoals, Mr. Cooper says, is that the latter depends upon the flow of water in the Tennessee River, which sometimes is low, affording 600,000 hp. when the river is full and only 100,000 hp. when it is low, while the Bay of Fundy dam will yield a minimum of 500,000 hp. throughout the year. The capacity, he says, can be increased to 700,000 hp., or enough to supply all New England and have some left to send to other states.

Governor Baxter of Maine has endorsed the project as have numerous chambers of commerce of Maine.

Mr. Cooper Has Studied Project Four Years

To concentrate on his scheme, which so far has progressed only to the drawing of specifications and surveys of the tides, Mr. Cooper has removed his offices in New York to a little island called Campobello, located several miles off shore from Eastport. There, within sight of the spot where he hopes to supervise the biggest hydraulic plant ever undertaken, he has surrounded himself with a corps of draftsmen and tide inspectors. His office is jammed with racks containing blue print calculations for the building of the dams and gates.

According to some engineers while the plan as outlined, to construct huge dams to utilize this water is perfectly feasible, yet the cost would be very great and there would be so much risk to the structure from abnormal tides that it would be difficult to enlist capital.

Chicago Drainage Canal Blamed for Low Water

Concern has been caused at Rochester by the fact that Lake Ontario is smaller and shallower now than it has been in the last quarter century. Government experts declare that the Chicago Drainage Canal, completed last year, which diverts water from Lake Michigan through Chicago and into the Mississippi Valley for sanitary purposes, is directly responsible for this condition.

At the Port of Rochester the river channel is dangerously shallow and a Government dredge is working to deepen it for the increasing number of coal freighters that are clearing the port loaded to capacity.

Lake Huron, now having fallen to a level of 578 ft., is nearly a foot lower than it was in 1895, the lowest point of record. Records of the lake levels have been kept since 1860.

Last Diamond Creek Hearing Will Be October 20

The final hearing before the Federal Power Commission in connection with the Girand project at Diamond Creek in the Colorado River has been postponed until Oct. 20. The time had been fixed tentatively for the first week in September, but on the application of those opposing the license and with the concurrence of Mr. Girand, the Power Commission has set the new date.

The Commission asks that objections be filed in writing prior to the meeting but an opportunity for oral argument will be afforded at the hearing, regardless of whether documents have been filed.

Big Pine Plant Rushed Into Service

The Bureau of Power and Light of Los Angeles placed the first 4,000-hp. unit of its Big Pine power plant in operation on July 31. Work on the installation was speeded up in order to be able to furnish emergency service to a number of mines and industrial plants in the Owens Valley region which were temporarily without power because of damage done to the feeder lines of the Southern Sierras Power Co. during a violent electric storm and cloudburst. Power from the Big Pine power plant is to be used in pumping water from approximately 300 wells in Owens Valley into the aqueduct for the water department of the city of Los Angeles.

Business Publishers Unite to Cover Foreign Markets

To meet adequately the demand for specialized business publications in the increasingly important field of overseas trade and industry a new corporation, The Business Publishers International Corp., located at 225 West 34th St., New York City, has been formed by the McGraw-Hill Co., Inc., and the United Publishers Corporation.

Three publications already existing form the nucleus of the new company. These papers are *Ingeniería Internacional* (International Engineering) a McGraw-Hill industrial and engineering Spanish language monthly, for Spanish and Latin American countries; *El Automovil Americano* and the *American Automobile* (Overseas Edition) which has a circulation in Australia, New Zealand, South Africa, India, Great Britain, Norway, Denmark, Holland, Belgium and the Orient.

Mason Britton, a vice-president of the McGraw-Hill Co., Inc., is to be president of the new company; John Abbink, until formation of the new publishing firm business manager of *Ingeniería Internacional*, is vice-president and general manager; J. L. Gilbert, who was business manager of the two automotive publications is vice-president and secretary; C. A. Musselman, president of the Chilton Class Journal Co., the automotive publications division of the United Publishers Corp., is treasurer. The board of directors includes in addition to the officers, Charles G. Phillips, president of the United Publishers Corp., Malcolm Muir, a vice-president of the McGraw-Hill Co., Philip S. Smith, editor of *Ingeniería Internacional* and George E. Quisenberry, editor of *El Automovil Americano* and *The American Automobile* (Overseas Edition).

The new corporation will follow closely the activities of the two parent companies, which are the largest in the world in their respective fields.

Technical Papers Program of N.A.S.E. Convention

The technical papers program of the N.A.S.E. convention, which is to be held in St. Paul, Aug. 31 to Sept 4 has been arranged as follows:

Tuesday afternoon—"The Evolution of the Synchronous Machine from the Earliest to the Present Time, Flywheel Type Synchronous Motors, A Review, A Prediction," by Theodore Schou, chief engineer Ideal Electric & Mfg. Co., Mansfield, Ohio.

Tuesday evening—Motion pictures of the electrical industry. Pictures of "A Trip Through the Westinghouse Works," "An Electrical Travelogue," "White Coal," with E. H. Sniffen, power sales department of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., as speaker.

Wednesday morning—"Centralized Combustion Control by Mechanical Means—Methods of Handling Large Unit Boilers at Highest Ratings Obtainable at Highest Possible Efficiency," by Joseph F. Shadgen, Smoot Engineering Corporation.

Thursday morning—"Power Factor—Low Power Factor, How Corrected—Applications of Motor Generator Sets and Voltage Control of Machines Through Them," by a speaker from the Electric Machinery & Manufacturing Co., Minneapolis, Minn.

Thursday afternoon—Welfare paper.

U. S. Steam Plant at Muscle Shoals Paying

For the first time since 1921, when its lease to the Alabama Power Co. began, the steam power plant of the United States Nitrate Plant Number 2 is operating at full capacity. Heretofore it has operated at varying capacities but not until now, to relieve the shortage of hydro-electric power caused by the severe drought of the early summer, has it been called upon for its full output of 60,000 kw. This power is being turned into the interconnected power system of the Alabama Power Co. to feed the States of North Carolina, South Carolina, Alabama and Georgia.

Nitrate Plant Number 2, one of the largest ordnance plants in the world, built to help make the United States independent of outside sources of nitrates for explosives manufacture, is occupying the exceptional status of earning a cash return to the Government. Under the terms of the lease, the United States receives a revenue of approximately $2,500 per day during the period of capacity operation of the plant.

Past President of N. A. S. E. Dies at His Post

Roderick Mackay, maintainance engineer of the Los Angeles water system, died suddenly in the keeper's lodge at Freeman station on the aqueduct on August 6. The strain of his untiring effort to speed up the huge task of repairing the damage suffered by the Los Angeles aqueduct through recent cloudbursts is known to have been the cause of his collapse and death. Mr. Mackay was born in Glasgow, Scotland, sixty-two years ago. He went to Los Angeles in 1889 where he served as mechanical engineer during the construction of the aqueduct, remaining in that position until several years ago when he became maintainance engineer upon the transfer of city engineer, H. A. Van Norman. He was a past president of the N. A. S. E., and a member of the Scottish Rite Masonic organizations of Los Angeles. He leaves, beside his sorrowing fellow engineers of the Water Bureau, a widow and one daughter.

S. Insull Honored as Head of Museum of Engineering

On August 17 a luncheon was given to honor Samuel Insull, as president of the National Museum of Engineering and Industry, by the Joint Committee of the Four Founders Societies at the Engineers' Club. The presidents, or their representatives, and the secretaries of these societies present were: Dr. Pupin, president, and F. L. Hutchinson, secretary, representing the A.I.E.E.; Fred R. Low, representing Dr. Durand, president, and Calvin W. Rice, secretary, for the A.S.M.E.; John R. Freeman, representing the president, and George T. Seabury, secretary, for the A.S.C.E.; J. V. Reynders, president, and H. Foster Bain, secretary, for the A.I.M. & M.E. About twenty prominent engineers were present including beside those mentioned, Frank J. Sprague and John W. Lieb.

On invitation of Mr. Insull, each of the Four Founder Societies is to recommend two of its members to serve on the Board of Trustees of the Museum.

Personal Mention

S. B. Flagg has recently resigned his position with the Riley Stoker Corp. and is again associated with the Electric Bond & Share Co. as fuel expert.

Raymond Wilcox, formerly with Dwight P. Robinson & Co., Inc., has become treasurer and general manager of the Engineering Corp., recently incorporated to conduct a manufacturing business in Long Beach, Calif.

Harold S. Boardman, dean of the college of technology, University of Maine, has been made acting president of the University to take the place of Dr. Clarence C. Little who resigned to accept the presidency of the University of Michigan.

E. J. Kingsbury and **E. E. King,** formerly with Dwight P. Robinson & Co., Inc., have opened an office in the Grant Bldg., Los Angeles, Calif., as consulting engineers under the name of Kingsbury & King. Mr. Kingsbury is also president of the Engineering Corp. of Long Beach, Calif., and is the inventor of several patented devices which bear his name and which will be manufactured by this corporation.

E. E. Hunt, who has been associated in the management of many conventions, conferences and committee meetings, has written a book on the conduct of such gatherings. Since assemblies of this nature require large aggregate outlays of money, Mr. Hunt, who is an assistant to Commerce Secretary Hoover, feels that he is doing a public service by pointing out the procedure which long experience has shown to be the most effective.

Frank L. Hess, a geologist who has served twenty-three years on the staff of the United States Geological Survey, has resigned to become chief mineral technologist for the Bureau of Mines. Heretofore, this work, as well as that of the chief chemist, has been performed by one man. With the resignation of Dr. S. C. Lind, some months ago, it was decided to have a chief mineral technologist, as well as a chief chemist.

George Emmons, formerly vice-president of the General Electric Co., in charge of manufacturing, and who retired last November, after forty-five years of service with the company, received a tribute from his former associates when a bronze tablet in his honor was unveiled at the Schenectady plant the middle of July. The tablet was made by Chester Beach and was provided by contributions from thousands of employees in the plant with whom Mr. Emmons was associated during his service with the G. E. Co.

Business Notes

The Girtanner Engineering Corp., 1400 Broadway, New York City, announces the opening of a new district office in St. Louis, Mo., at 915 Olive St., with Louis Frank Mahler as district manager in charge.

The Uehling Instrument Co., Paterson, N. J. has recently appointed John C. Candler, 315 Glenn Bldg., Atlanta, Ga., as agent for Georgia, eastern Tennessee and the southern half of South Carolina, and Charles M. Setzer, of Charlotte, N. C. to cover North Carolina and the northern half of South Carolina.

R. D. Wood & Co., manufacturers of hydrants and valves, Philadelphia, Pa., announce that C. R. McGahey, formerly with the Worthington Pump & Machinery Corp. as meter representative, has been appointed their district representative for North and South Carolina, Alabama and Georgia, with headquarters in the Bona Allen Bldg., Atlanta, Ga.

Coming Conventions

American Electric Railway Association. James W. Walsh, 8 West 40th St., New York City. Convention and exhibits at Young's Million Dollar Pier, Atlantic City, N. J., Oct. 5-9.

American Electrochemical Society. Dr. Colin G. Fink, Columbia University, New York City. Convention at Chattanooga, Tenn., Sept. 24-26.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Pacific Coast convention, Seattle, Wash., Sept. 15-17.

American Institute of Mining and Metallurgical Engineers. H. Foster Bain, 29 West 39th St., New York City. Autumn Meeting at Salt Lake City, Aug. 31-Sept. 3.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Fall meeting at Montreal, Oct. 14-16.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

American Society of Refrigerating Engineers, William H. Ross, 154 Nassau St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

Association of Edison Illuminating Companies. Preston S. Miller, 80th St. and East End Ave., New York City. Annual meeting at New Arlington Hotel, Hot Springs, Ark., Oct. 19-23.

Association of Iron & Steel Electrical Engineers. John F. Kelly, Empire Bldg., Pittsburgh, Pa. Annual meeting at Philadelphia, Pa., Sept. 14-19.

Chemical Industries. Tenth Exposition at Grand Central Palace, New York City. Sept. 28-Oct. 3.

Electric Power Club. S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Fall meeting at Briarcliff Manor, N. Y., Oct. 19-22.

Empire State Gas & Electric Association. C. H. B. Chapin, 5618 Grand Central Terminal Bldg., New York City. Meeting at Lake Placid Club, N. Y., Oct. 1 and 2.

Illuminating Engineering Society. Norman D. MacDonald, 29 West 39th St., New York City. Convention at Detroit, Mich., Sept. 14-18.

Iron and Steel Exposition. John F. Kelly, 706 Empire Bldg., Pittsburgh, Pa., Sept. 14-19. Exposition at the Philadelphia Commercial Museum, Philadelphia, Pa., Sept. 14-19.

National Association of Practical Refrigerating Engineers, Edward H. Fox, 5707 West Lake St., Chicago, Ill. Sixteenth annual convention and educational exhibition at Statler Hotel, Detroit, Mich., Dec. 8-12.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **Minnesota Association** at St. Paul, Aug. 24-28. A. Nelson, 800 22nd Ave., Minneapolis, Minn.

National Exposition of Power & Mechanical Engineering. Fred W. Payne, Manager, Grand Central Palace, New York City. Exposition at Grand Central Palace, Nov. 30-Dec. 5.

National Safety Council. G. H. Cameron, 168 North Michigan Ave., Chicago, Ill. Fourteenth Annual Safety Congress at Cleveland, Ohio, Sept. 28-Oct. 2.

New England Water Works Association, Frank J. Gifford, Dedham, Mass., sec. Convention to be held aboard "Richelieu," en route Montreal to Quebec, etc., Sept. 8-11. For details apply to George E. Marsters, Inc., 248 Washington St., Boston, Mass.

Trade Catalogs

Blowers — The Connersville Blower Co., manufacturers of rotary positive pressure blowers, gas exhaustors and pumps, Connersville, Ind., has recently published "Bulletin 6A" covering the different types of pumps used for priming large centrifugal pumps by exhausting the air from the centrifugal pump and its piping.

Electrical Supplies — The Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. This company has just issued its regular large, cloth-covered catalog of electrical supplies for 1925-27, which contains 1,185 pages of well-illustrated material describing this equipment. It is indexed and contains tables of sizes and capacities.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Aug. 17, 1925
Pool 1	New York	$2.35@$2.75
Smokeless	Boston	1.59
Clearfield	Boston	1.65@1.90
Somerset	Boston	1.75@2.00
Kanawha	Columbus	1.35@1.50
Hocking	Columbus	1.45@1.70
Pittsburgh	Pittsburgh	1.90@2.00
Pittsburgh gas slack	Pittsburgh	1.40@1.60
Franklin, Ill.	Chicago	2.25@2.50
Central, Ill.	Chicago	2.00@2.25
Ind. 4th Vein	Chicago	2.25@2.50
West Ky.	Louisville	1.10@1.50
S. E. Ky.	Louisville	1.35@1.75
Big Seam	Birmingham	1.50@2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.25@$2.60
Buckwheat No. 1.	Philadelphia	2.50@2.75
Birdseye	New York	1.60@1.90

FUEL OIL

New York—Aug. 20, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal., 36@40 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

St. Louis — Aug. 11, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.85 per bbl.; 26@28 deg., $1.90 per bbl.; 28@30 deg., $1.95 per bbl.; 30@32 deg., $2.00 per bbl.; 32@36 deg., gas oil, 5c. per gal.; 38@40 deg., 5.6c. per gal.

Pittsburgh — Aug. 11, f.o.b. local refinery; 30@34 deg., fuel oil, 5⅜c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Dallas—Aug. 15, f.o.b. local refinery, 26@30 deg., $1.55 per bbl.

Philadelphia—Aug. 14, 27@30 deg., $2.15@$2.21 per bbl.; 18@22 deg., $1.848@$1.908; 13@19 deg., $1.575@$1.635 per bbl.

Boston—Aug. 10, tank-car lots, f.o.b. heavy oil, 12@14 deg., Baumé, 4¼c. per gal.; light oil, 28@32 deg. Baumé, 5¼c. per gal.

Cincinnati — Aug. 18, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 5⅛c. per gal.; 26@30 deg., 5⅜c. per gal.; 30@32 deg., 5⅝c. per gal.

Chicago — Aug. 11, tank-car lots, f.o.b. Chicago, 24@26 deg., $2.03 per bbl.; 30@34 deg., $2.23; 36@40 deg., 6c. per gal.

New Plant Construction

Ala., Wetumpka—Alabama Power Co., B M Bldg., Birmingham, has received permission from the Alabama Public Service Comn. to construct a hydro-electric development at Lock 8 on the Coosa River near here, 170,000 hp. ultimate capacity. Estimated cost $13,000,000.

Calif., Berkeley—R. O. Long Co., 2114 Shattuck Ave., plans the construction of a hotel and office building at Shattuck and University Aves. Estimated cost $1,500,000.

Calif., Los Angeles—Petroleum Securities Co., E. L. Doheny, Jr., V. Pres., is having plans prepared for the construction of a 12 story office and theatre building at 11th and Hill Sts. Estimated cost $2,000,000. Dodd & Richards, Brack-Shops Bldg., are architects.

Calif., Los Angeles—Sunset Silk Hose Mills, F. B. Norman, Mgr., 433 Grosse Bldg., is receiving bids for the constructon of a 2 story factory including a boiler plant, electric freight elevators, sprinkler system, etc., on San Fernando Road. Estimated cost $80,000. M. H. Merrill & Co., 615 Laughlin Bldg., are architects.

Calif., San Francisco—City is having plans prepared for furnishing and installing two 6-in. vertical pumps, motors, etc. at Great Highway and Vicente St. Estimated cost $6,500. M. M. Shaughnessy, is city engineer.

Conn., Watertown—Watertown Mfg. Co., awarded contract for the construction of a power house and manufacturing building on Echo Lake to Tracy Bros., 52 Benedict St. Estimated cost $75,000.

D. C., Washington—H. A. Flint, General Purchasing Officer of the Panama Canal, will receive bids until August 31st for a boiler and condenser, transformer, etc.

Ill., Aurora—Western United Gas & Electric Co., 36 Fox St., awarded contract for the installation of a 20,000-kw. turbo generator unit, two additional 1,000 hp. Stirling boilers, coal and ash handling equipment, etc., to Stone & Webster, Inc., 147 Milk St., Boston, Mass. Electric equipment to be enlarged and adapted to new unit.

Ill., Chicago—R. S. DeGoyler & Co., 307 North Michigan Ave., Archts., will receive bids until September 15th for the construction of a 15 story apartment including 2 passenger and 2 freight elevators at 1320 North State St., for H. O. Stone & Co., 5 North Clark St. Estimated cost $1,800,000.

Ill., Chicago—Nine Hundred Michigan Ave. North Building Corporation, c/c Ross & Browne, 80 East Jackson St., will receive bids until September 15th for the construction of a 9 story apartment. Estimated cost $2,500,000. J. Hunt, 30 North Michigan Ave., is architect.

Ill., Granite City—St. Louis Coke & Iron Co., 117 North 4th St., St. Louis, Mo., plans the construction of addition to power plant and new blast furnace here. Estimated cost $2,000,000.

Kan., Greensburg—A. C. Reed, Clk., will soon receive bids for the construction of a waterworks system and power plant. Estimated cost $30,000.

Kan., Kansas City—City is having plans prepared for electrical improvements including a new boiler plant and equipment. Estimated cost $650,000 to $700,000. A. L. Mullergren, 555 Gates Bldg., Kansas City, Mo., is engineer.

Md., Baltimore—Mayor and City Council, City Hall, plans the construction of a 9 story office building at Lexington, Holliday and Guilford Aves. Estimated cost $1,500,000. W. H. Emory, Jr., 18 East Lexington St., is architect. Engineer not selected.

Mass., Boston—Bd. of Trustees, City Hall, will receive bids until August 26th for the installation of a heating and ventilating system in Boston Sanitorium, 5761 East Concord St. Estimated cost $25,000. Maginnis & Walsh, 100 Boylston St., are engineers.

Mass., Boston—Boston Ice Co., 110 State St., subsidiary of Knickerbocker Ice Co., 41 East 42d St., New York, is receiving bids for the construction of an ice plant on Albany St. Estimated cost $100,000. Private plans.

Mass., Charleston (Boston P. O.)—S. M. Howes, 509 Medford St., awarded contract for the construction of a 3 and 4 story factory and heating plant on Medford St. to H. L. Hauser Building Co., Inc., 263 Summer St., Boston. Estimated cost $100,000.

Minn., Moorhead—City will receive bids until August 28th for mechanical equipment for power plant, including boilers, stokers, superheaters, turbine generator units, condensers, etc. Toltz King & Day, Builders Exchange Bldg., St. Paul, are engineers.

Miss., Isola—F. H. Hutson, Mayor and Bd. of Alderman, will receive bids until September 8th for the construction of a waterworks system including pump house, oil engine, tank on tower, reservoir, etc.

Mo., Republic—City is having plans prepared for the installation of a 500 g.p.m. pump and motor, 75,000 gal. tank on tower, mains, etc. Gantt & Baker, 1st National Bank Bldg., Oklahoma City, Okla., are engineers.

Mo., St. Louis—Joyner Realty Co., c/o D. R. Harrison, 6053 Waterman Ave., Archt., awarded contract for the construction of a 6 story apartment at Enright and Hamilton Sts. to Harrison Construction Co., 5715 Delmar Blvd. Estimated cost $500,000.

Mo., St. Louis—Mound City Cold Storage Co., 3019 North 9th St., awarded contract for the construction of a cold storage plant at 9th and Branch Sts. to A. Groceman, 7218 Normandy Place. Estimated cost $40,000.

Neb., Yutan—Martin & Heyn Co., Omaha National Bank Bldg., Omaha, is receiving bids for the construction of a waterworks system including two 300 or one 600 g.p.m. centrifugal pumps, 50,000 gal. tank on tower, etc., here.

N. Y., New York—J. Golding, c/o Sugarman & Berger, 345 Madison Ave., Archts. and Engrs., is having plans prepared for the construction of a 15 story apartment at Madison Ave. and 86th St. Estimated cost $3,000,000.

N. Y., New York—Kingsbridge Import Co., c/o E. Roth, Archt., will build a 14 story apartment at 5th Ave. and 93rd St., by day labor. Estimated cost $1,300,000.

N. Y., New York—Lakin Realty Corporation, c/o E. Roth, 119 West 40th St., Archt. and Engr., will build a 14 story apartment at 119 West 57th St., by day labor. Estimated cost $1,200,000.

N. Y., New York—S. & L. Building Corporation, c/o E. Roth, 119 West 40th St., Archt., will build a 15 story apartment at Broadway and 101st St. by day labor. Estimated cost $1,600,000.

N. Y., New York—Six Hundred Seven West End Ave. Corporation, c/o R. Candella, 200 West 2nd St., Archt. and Engr., will build a 16 story apartment at 607 West End Ave., by day labor. Estimated cost $500,000.

N. Y., Orlean—Common Council, A. E. Turner, Clk., City Hall, will receive bids until August 27th for the construction of a sanitary sewage system and pumping station including 2 centrifugal pumps, 1 electric motor, gasoline engine, etc. H. B. Cleveland, 38 Park Row, New York, is consulting engineer.

N. Y., St. George—N. J. Hayes, Comr. of Water Supply, Gas and Electricity, Room 2351, Municipal Bldg., Manhattan, will receive bids until August 28th for the construction of a new building for the Clove pumping station also furnishing and installing a pumping and generating plant complete here.

N. Y., Wingdale—State Hospital Comn., Capitol, Albany, will receive bids until September 16th for the construction, heating, sanitary, electric work and refrigeration of a group of buildings for Harlem Valley Hospital. S. W. Jones, Capitol, Albany, is architect.

O., Cleveland—Mt. Sinai Hospital, F. T. Halle, Chn. of Building Comn., East 105th St. and Ansel Road, awarded contract for the construction of a group of buildings including a boiler house to Reaugh Construction Co., 2835 East 51st St. Estimated cost $1,000,000.

Okla., Talihina—City is having preliminary plans prepared for the construction of a new well, pump, water mains, etc. Estimated cost $16,000.

Pa., Philadelphia—Branson Bond & Mfg. Co., Stock Exchange Bldg., will build an 8 story apartment at 4111 Walnut St. by day labor. Estimated cost $900,000. Watson Co., 15 Park Row, New York, is architect.

Pa., Philadelphia—Bureau of Yards and Docks, Navy Dept., Washington, D. C., will receive bids until August 26th for an electric driven pump, 50,000 gal. steel water tank on tower, etc., for Naval Home here.

Pa., Philadelphia—J. Catlan et al, c/o Magaziner, Eberhard & Harris, 603 Chestnut St., Archts., will soon award contract for the construction of a 12 story office building on 13th St. Estimated cost $800,000.

Pa., Philadelphia—Pennsylvania R.R., Broad St. Station, E. B. Temple, Asst. Chief Engineer, will receive bids until September 1st for the construction of a 14 story office building including 14 passenger and 1 freight elevator. Estimated cost $2,000,000. Graham, Anderson, Probst & White, Railway Exchange Bldg., Chicago, Ill., are architects.

Pa., Philadelphia—R. Seltzer, Agt., 1433 Locust St., having revised plans prepared for the construction of a 12 story apartment at 15th and Spruce Sts. W. H. Gravell and A. Hall, Otis Bldg., are engineers. Former bids rejected.

Pa., Pine Grove—Pennsylvania Power & Light Co., Allentown, awarded contract for the construction of addition to power plant here to Phoenix Utility Co., Allentown. Estimated cost $3,600,000.

Pa., Pittsburgh—Peter Miller, Inc., 600 Majestic Bldg., Detroit, Mich., is having plans prepared for the construction of an 11 story hotel at 5th Ave. and Dithridge St., here. Estimated cost $3,000,000. H. Hornbostel, Hardy Hays Bldg., is architect.

R. I., Providence—Providence Gas Co., awarded contract for the construction of a service station including a boiler house, etc., at Potter Ave. and Dexter St., to Aberthaw Construction Co., 27 School St., Boston, Mass. Estimated cost $300,000.

Tex., Anson — City plans an election August 25th to vote $60,000 bonds for improvements to waterworks, including pumping equipment, mains, and sewer system, and probably disposal plant. Engineer not selected.

Tex., Idalou—Montgomery & Ward, 1016 City North Bank Bldg., Wichita Falls, Engrs., will receive bids until August 31st for improvements to waterworks system including pumping equipment, tank on tower, etc., for city. Estimated cost $30,000.

Tex., Gonzales—Middle West Utilities Co., J. B. Martin, Mgr., Frost Bldg., San Antonio, is having plans prepared for the construction of a 30 ton ice plant and a filter plant in connection with present power plant. Machinery will be required. Estimated cost $45,000. M. J. Mozart, Frost Bldg., San Antonio, is company engineer.

Virginia—Stone & Webster, J. H. Manning, Gen. Mgr., of Engineering Div., c/o Virginia Railway Power Co., Richmond, Va., will make preliminary surveys for a hydro-electric development linking the James and Appomattox rivers at Petersburg, Va., and Roanoke Rapids, N. C. Ultimate cost $12,000,000.

Wash., Seattle—City Council has introduced an ordinance providing for an election to vote $1,653,000 bonds for the construction of the first unit of a system of pumping plants, intercepting sewers and a trunk sewer from Lake Washington to Puget Sound.

Wash., Seattle—C. Cornelius, c/o F. H. Fowler, L. G. Smith Bldg., awarded contract for the construction of a 9 story apartment at 3rd and Blanchard Sts. to Walter & Brady, Hoge Bldg. Estimated cost $600,000.

Wis., Eau Claire—Eau Clair Coffee Co., 121 South River St., awarded contract for the construction of a 2 story cold storage plant to Hoeppner-Bartlett Co., 414 East Grand Ave. Estimated cost $75,000.

Wis., Kenosha—Bd. of Education, will soon award contract for the construction of a boiler plant including pumps, coal and ash handling machinery, etc. Boilers and stokers have been purchased. J. H. Chubb, 109 North Dearborn St., Chicago, Ill., is architect.

Ont., Fordwich—Township Council, C. E. Walker, Clk., is interested in prices of complete equipment for electric light and power system both hydro-electric and development of local power.